POWER PLANT ENGINEERING

Established Over 29 Years

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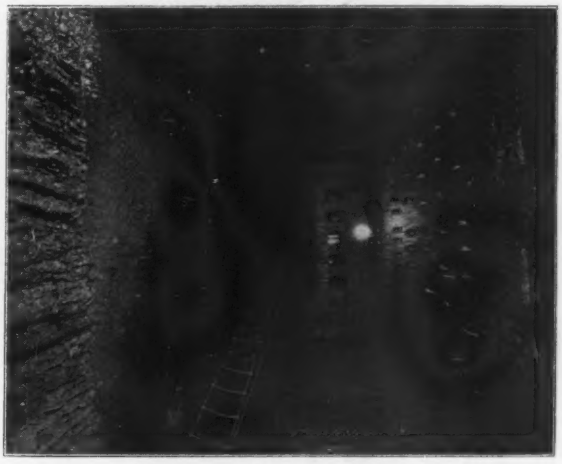


Over Your Head

IF THIS PICTURE is over your head, it is not over your head. No, this is not another one of those riddles like "When is a door not a door?" or "When is a sailor not a sailor?" You know that, in the slang of the day, when we say a thing is "over your head," it means that you don't quite understand it. So, in case the above picture is at first glance a little "over your head," hold it at arms length directly over your head and look upward at it. Then it won't be "over your head." Clear as mud, isn't it?

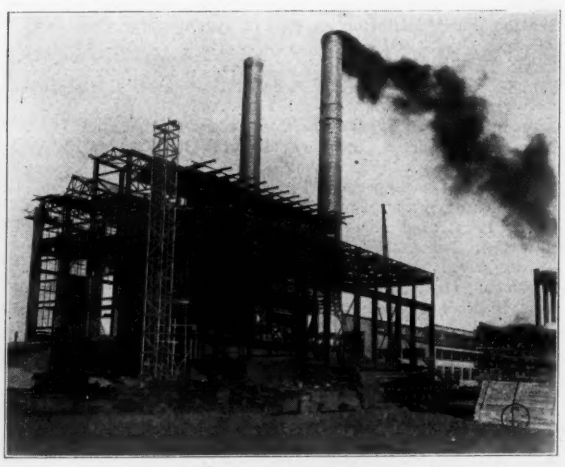
As a matter of fact, when you hold the picture according to these directions, you get the effect of looking up into this 10,000-cu. ft. boiler furnace from the same point at which the camera was placed to take the photograph. This is the furnace for a 1361-hp. boiler, equipped to burn nine different kinds of fuel, and installed with three similar ones in the new power plant of the Ford Motor Co., at Iron Mountain, Mich. This plant has just been built to supply steam and power to a large factory there, which fabricates various wooden parts for that familiar automotive device that has made Detroit famous.

This picture was taken after the boiler had been in continuous operation for one year at ratings of 250 to 300 per cent. Ordinarily the fuel used in these four boilers consists almost entirely of industrial by-products, such as wood waste from the sawmills and body plants and gases, oils, tar and charcoal from a wood chemical plant. To these plants, as well as to the largest battery of dry kilns in the world, the power house renders a variety of services, as described in this issue.

Iron Mt. Plant Makes Power From Wood Waste

SAWDUST, WOOD, GAS, OIL AND CHARCOAL, OBTAINED AS BY-PRODUCTS FROM WOODWORKING AND CHEMICAL PLANTS OF FORD MOTOR CO., MAKE STEAM AND POWER FOR THOSE PLANTS AND FOR DRY KILNS

RECEIVING NEARLY ALL its fuel in the form of wood waste and chemical by-products from a sawmill, three enormous body plants and a wood chemical plant and supplying power, heat and process steam to those plants in addition to furnishing steam to the largest battery of dry kilns in the world, the new power house of the Ford Motor Co. at its plant at Iron Mountain, Mich., forms a most interesting industrial installation. Rounding out this arrangement, a hydro-electric plant has been built, on the Menominee River about a mile from the steam plant, operating in parallel with it. The principal feature of interest in this power plant is that nearly 100 per cent of its fuel consists of waste products from the industrial departments of the factory. In order to utilize these waste products to the best advantage, it was necessary to give careful attention to all phases of the design and operation of the industrial departments as well as of the power house. The whole industrial organization at Iron Mountain constitutes an endless chain of production units, the functions of each unit depending on the operation of all the others; the power house forms an important link in this chain. Some discussion of the basis on which the various industrial units were designed, will give a better idea of the considerations that influenced the design of the power house that is to be described here.



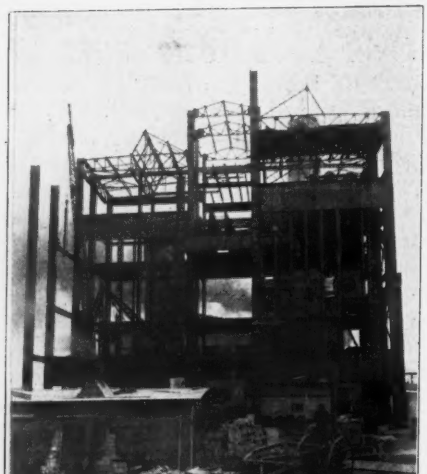


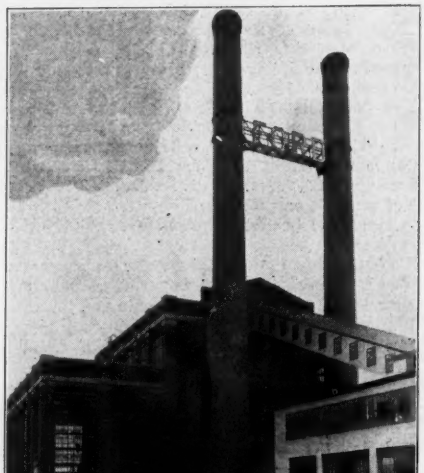
FIG. 1. PROGRESS OF CONSTRUCTION WORK AT IRON MOUNTAIN PLANT

A—Supporting steel for Boiler No. 1 was in place Sept. 30, 1923. Boiler drum resting on foundation is about to be hoisted into position.

B—Condition of Boiler No. 1 and steel work on Nov. 9, 1923. Furnace brickwork and chimney are being erected; No. 1 boiler is in place.

C—Steam was raised on Dec. 1, in Boiler No. 1, which made "smoke by request" on Dec. 8, 1923, 100 days after beginning construction, to show that plant is in operation.

D—The completed plant as it appears at present, showing horizontal stack, overhead pipe tunnel and dust catchers.



In the northern peninsula of Michigan, the Ford Motor Co. owns large tracts of timber land from which it obtains lumber necessary in the manufacture of Ford cars. Iron Mountain, a city of about 10,000 population, is located in the northern peninsula of Michigan about 100 mi. southeast of the Ford timber lands in Ontonagon county and about the same distance south of the company's sawmills at L'Anse and Pequaming. On account of transportation and labor conditions, and its proximity to the lumber to be handled, as well as other factors which cannot be dis-

cussed here, it formed a logical site for the location of these woodworking plants. Sound economic principles governed the decision to build at Iron Mountain the various industrial units mentioned above. Logs from the company's timber land, arriving at the Iron Mountain plant, are made into lumber by a sawmill. In order to save the enormous freight bills that would be paid on the water contained in this lumber if it were shipped to Detroit, the dry kilns were constructed. The body plants, reducing the dry lumber to body parts, eliminate the shipment of waste wood to the assembling plants, thus making possible another large saving in freight rates. But in the operation of the sawmill and body plants so much wood waste is produced that, if it were all burned, it would provide more than sufficient fuel to furnish steam to the dry kilns and to generate power for the machinery of the sawmill and body plants. Not only that, but this wood waste contains valuable chemical substances required in the production of Ford cars. It was decided, therefore, to install a chemical plant or wood treatment plant, which would convert the principal part of this wood waste into chemicals, incidentally providing certain chemical by-products, which could be returned to the power house and burned as fuel.

It can be seen, therefore, that in designing the power house the engineers of the Ford Motor Co. were confronted with a problem entirely different from that usually encountered in power plant work, for there were approximately nine different kinds of fuel to be consumed in the power house, which must in turn render two or three kinds of service to the industrial departments that supplied most of this fuel in the form of waste from the industrial processes. In the body plants, dry chips, shavings and dry sawdust were produced that would lend themselves well to burning in suspension. The sawmill produced wet sawdust and hogged fuel, which would probably have to be burned on grates. The chemical plant supplied gas, oil, tar and charcoal. On account of the fact that the chemical plant would also consume more wood waste than it could produce in by-products, the pulverized coal installation was added to supplement the arrangement, bringing the total number of fuels to nine.

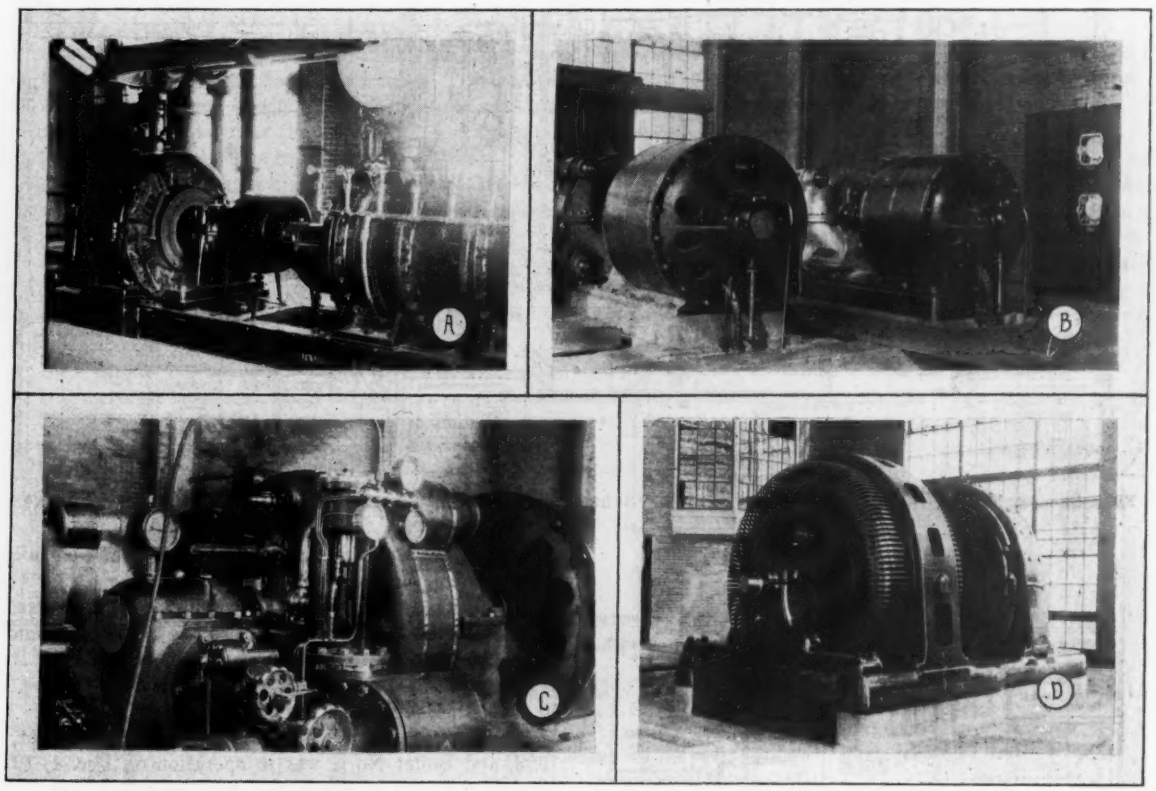


FIG. 2. PRIME MOVERS AND ELECTRICALLY-DRIVEN AUXILIARIES AT IRON MOUNTAIN PLANT

A—This 1000-g.p.m. centrifugal boiler feed pump is driven by a motor. A 1500-g.p.m. turbine-driven pump, just behind it, is kept for a reserve. B—View of two 750-kw. turbo-generators temporarily located in the main turbine room. These will be removed when the 5000-kw. units are installed. C—Close-up of 750-kw. unit shows governor, lubricating system and gages. D—One of the 1500-kw. motor-generator sets furnishing d.c. to the woodworking machinery in the various departments of the factory and to ring bus system through mill.

Before the construction of the new power plant at Iron Mountain, the boiler house had been burning its wood waste on flat grates in surface burning dutch ovens. Investigation showed that the wet and dry sawdust could all be burned in suspension, but that a grate would need to be provided for the hogged fuel. For the boilers of the new power house, therefore, a standard form of pulverized coal setting was decided upon, designed to admit all the fuel at the top, but with a grate added at the bottom to catch any fuel that did not burn in suspension.

This power plant was designed to render the following services: (1) to furnish low pressure steam for heating and spraying in the dry kilns; (2) to furnish electric power and heat to the body plants; (3) to furnish steam, electric power and heat to the sawmill; (4) to supply the

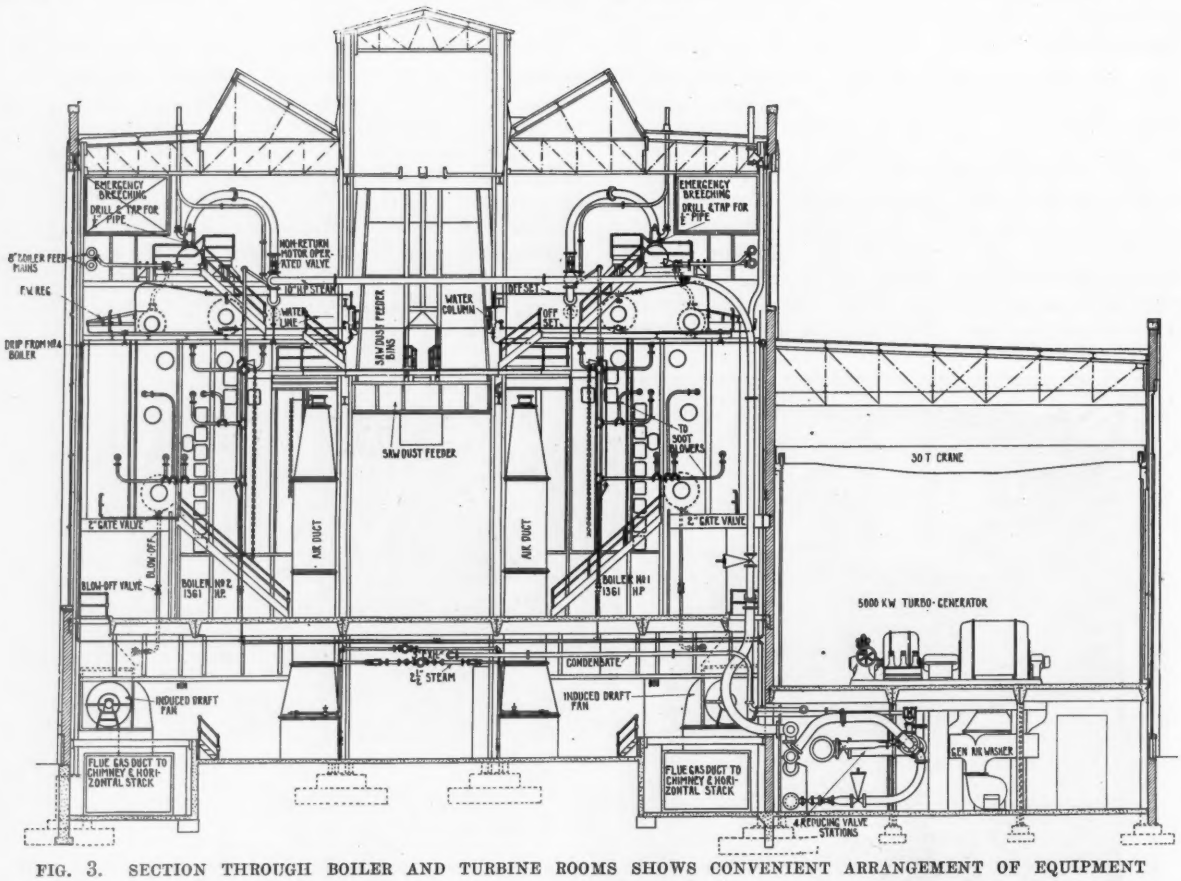


FIG. 3. SECTION THROUGH BOILER AND TURBINE ROOMS SHOWS CONVENIENT ARRANGEMENT OF EQUIPMENT

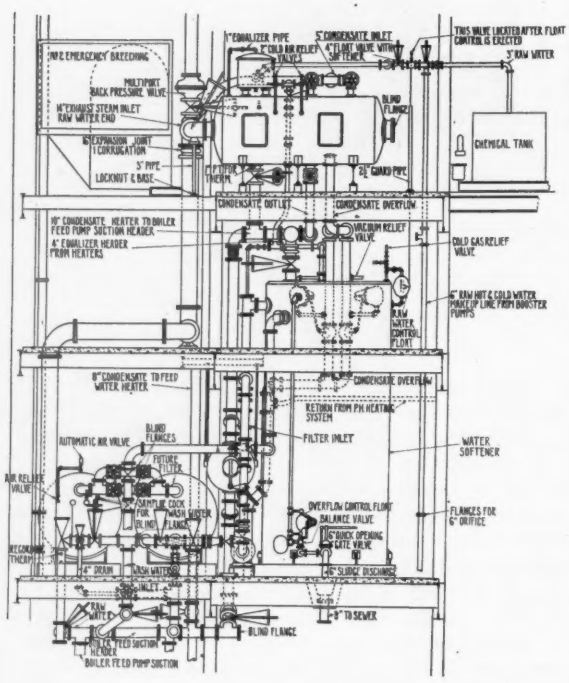


FIG. 4. WATER SOFTENER IS DIVIDED INTO TWO PARTS, ONE HANDLING CONDENSATE AND THE OTHER TREATING RAW MAKE-UP WATER

chemical plant with flue gas for drying wood and chemicals and steam for process work and heating.

As shown in Fig. 1D, the completed building is of steel and brick construction, with stone trimmings, and a concrete tile roof, covered with sheet metal roofing. It is 111 ft. wide by 140 ft. long, the turbine room taking up 50 ft. of the length and the boiler room 90 ft.

Construction of this steam plant was begun Sept. 1, 1923, and Boiler No. 1 was in operation on Dec. 1, 1923. This is a record of which the Ford engineers are justly proud, and more data concerning the construction work appear elsewhere in this article.

Four Water-Tube Boilers Give Plant a Capacity of 6524 B.hp.

Four 1361 hp. McAleenan water-tube boilers, each with 13,610 sq. ft. of heating surface were furnished by the McAleenan Corp. Each boiler has 877 tubes, connecting the 36-in. steam drum and 42-in. and 54-in. water drums. Flue gas makes 3 passes through the tubes as shown in Fig. 5.

Each furnace has a volume of 10,000 cu. ft., the furnace walls being of the air-cooled type, with McAleenan suspended arches. Air for these enters through dampers as indicated in Figs. 3 and 5, thence through the hollow walls and into the furnace through suitable openings in the brickwork, illustrated in Fig. 5. Draft control is by means of a Bailey automatic control system on the various dampers. One of these boilers is equipped with a National and one with a Huber stoker; the other two furnaces have Beaumont ash gates.

The boilers generate steam at 250 lb. gage pressure. Each boiler is equipped with an Elesco superheater, fur-

nished by the Superheater Co., of 800 sq. ft. heating surface, which gives the steam a superheat of 100 deg. F. Figure 5 shows the location of this superheater and Fig. 3 the piping and safety valve connections.

All piping for the plant was installed by the Pittsburgh Valve, Foundry and Construction Co.; pipe covering was furnished by Johns-Manville, Inc. Badger expansion joints are used on exhaust steam lines. Each boiler is equipped with four 4½-in. Crane safety valves and each superheater has a 3½-in. Consolidated safety valve.

Edward motor-driven stop and check valves were installed. Auxiliary electrical controls for all motor-operated valves are placed on various control boards, one of these being near the main entrance as shown in Fig. 6, for use in case of emergency. Eckenroth blowoff valves were used as indicated on the section, Fig. 3, all blowoff piping leading to a blowoff tank on the ground floor. This drawing also shows the location of the Copes feed water regulators installed on each boiler near the water level, and the piping for the Diamond soot blowers.

On the firing floor, which is just below the boiler water level, are the burner openings, pulverized coal and sawdust feeders and a control board for each boiler, as illustrated in Fig. 7. These control boards are equipped with Bailey multi-pointer gages showing draft, steam flow and steam pressure. Recording and indicating pyrometers and thermometers are also installed on steam and water lines, on the water softeners and elsewhere in the power house.

The firing floor is of iron grating fabricated in the Ford shops, supported on the building and boiler supporting columns. The large steel sash and overhead skylights admit light and air, making a comfortable working space. Steel stairways lead to gratings around the safety valves and stop valves; from these gratings also the boiler feed lines and their valves can be reached. At this level also are the heaters and chemical tank of the water softener, which will be described later.

Boilers Are Equipped to Burn Nine Different Fuels in Suspension

As stated above, nine fuels may be burned at the Iron Mountain plant: wood gas, wood oils, wood tar, wet and dry sawdust, hogged fuel, pulverized coal, pulverized charcoal and dry chips and shavings.

Complete equipment for burning pulverized coal is installed at the Iron Mountain plant. As explained below, oil was burned while the plant was being built, then pulverized coal. At present No. 1 and No. 2 boiler are burning sawdust, while Nos. 3 and 4 burn pulverized coal and the products of the wood treatment plant, together with some sawdust and shavings.

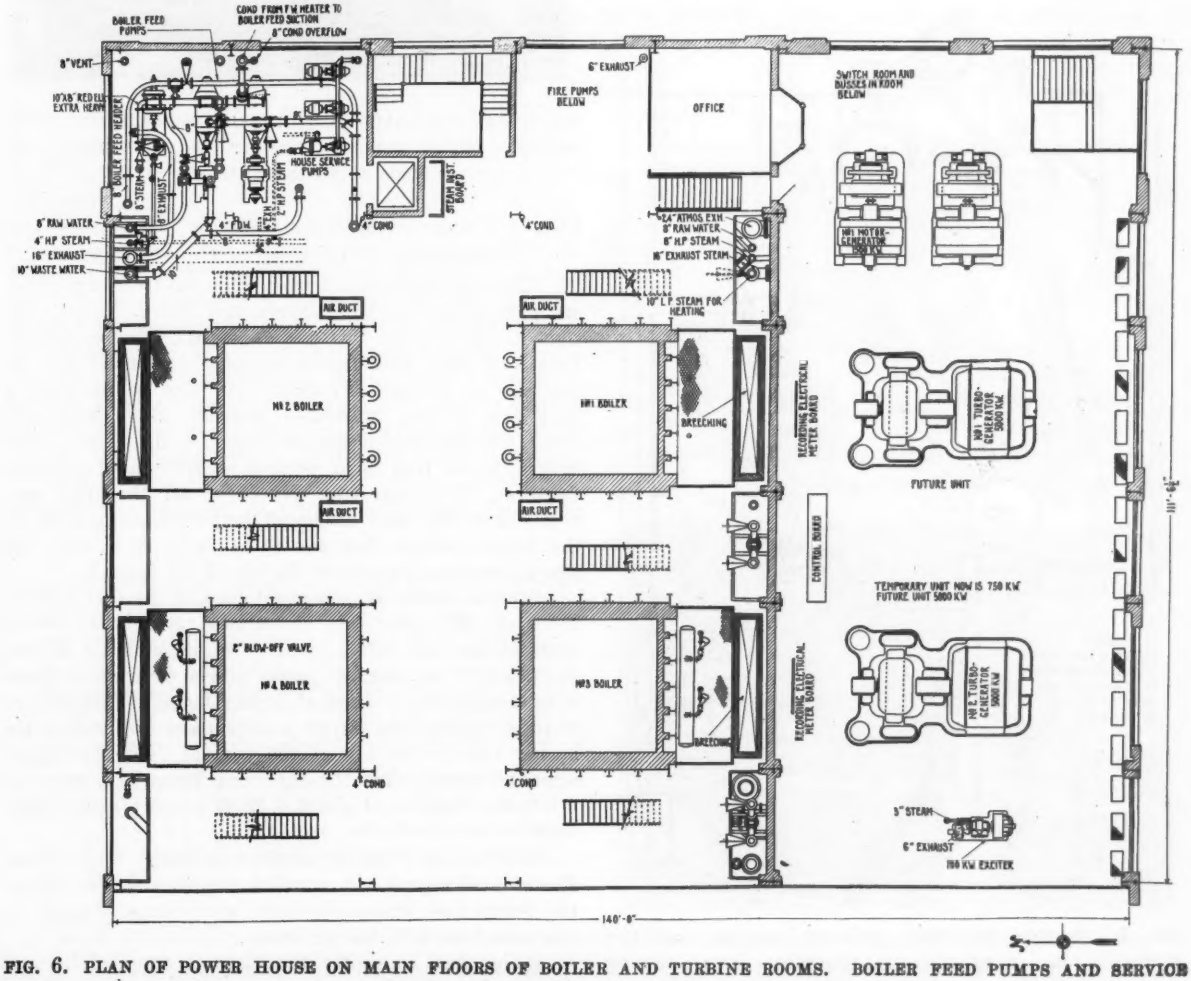


FIG. 6. PLAN OF POWER HOUSE ON MAIN FLOORS OF BOILER AND TURBINE ROOMS. BOILER FEED PUMPS AND SERVICE PUMPS ON GROUND FLOOR ARE ALSO SHOWN

Coal may be stored in the mill yard, space being available for 60,000 T. It is taken either from storage, or direct from the cars as it comes from the Ford Mines, by a locomotive crane. The coal preparation plant was designed and built by the Ford Motor Co. engineers. It is located in the same building as the wood-treatment plant, which is not shown here.

After the coal is weighed, it goes to a hopper feeding a Link-Belt roll crusher, from which a belt conveyor takes it over a magnetic pulley to a Link-Belt bucket elevator. This elevator transports it to two storage bins of 100 T. capacity each. From here a screw conveyor runs to the bins of the pulverizing equipment, which, together with the driers, have a capacity of about 15 T. The coal handling equipment was all furnished by Link-Belt Co., and can handle about 60 T. an hour.

Coal from the 15-T. bins passes to two Randolph driers and thence to two 6-roller Raymond air-separating pulverizers. Fuller-Kinyon fuel delivery pumps force the pulverized coal from the preparation plant to the power plant, the transporting pipes running through the overhead tunnel and entering the boiler house as shown in Fig. 1D. Here the pulverized coal is stored in bins in front of boilers 3 and 4, from which the pulverized fuel feeders force it through spouts to the burner openings. Figure 12 shows the spouts and feeders for boiler No. 4.

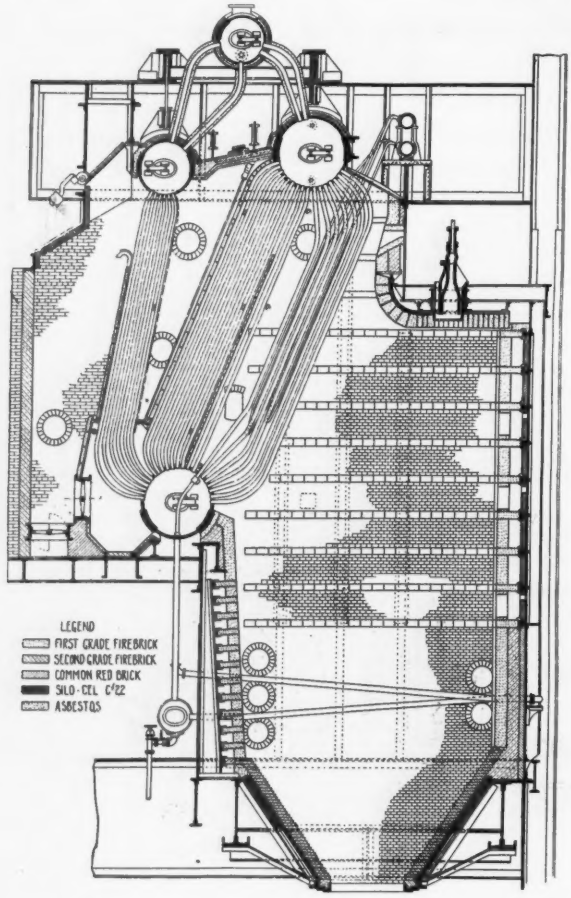


FIG. 5. SECTION THROUGH 1361-HP. BOILER, SHOWING SUPERHEATER, FURNACE CONSTRUCTION AND BURNER OPENINGS

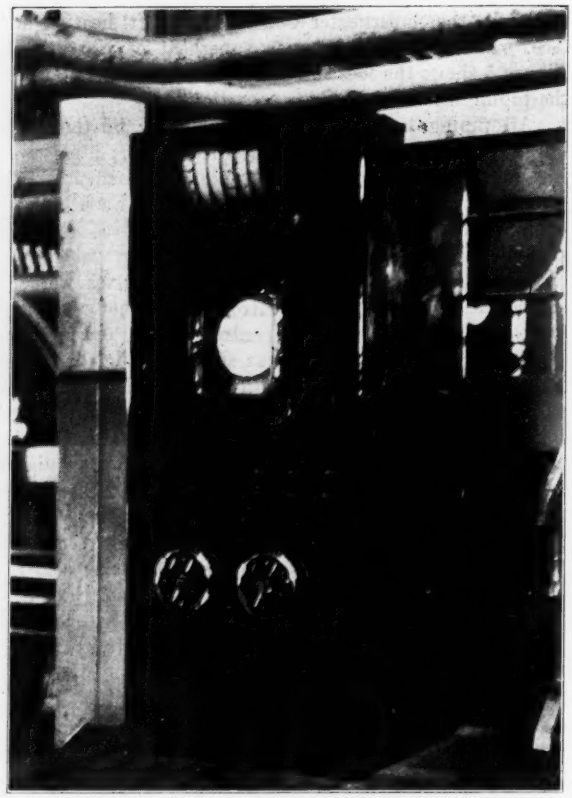


FIG. 7. CONTROL BOARD ON THE FIRING FLOOR BESIDE EACH BOILER CARRIES FULL EQUIPMENT OF INDICATING AND RECORDING INSTRUMENTS

Ford Engineers Designed Pumping Equipment and Burners for Wood Distillation Products

Wood tar and wood oil from the wood-treatment plant are pumped to the boiler house and fed to burners designed especially for this purpose by the Ford engineers. Details of these burners and pumping equipment are not available at present. Provision will also be made at a later date to burn pulverized charcoal. Non-condensable gases from the wood-treatment plant are also piped to the boilers, where they burn as soon as introduced into the furnaces. The conveying pipes for all this fuel run overhead so that they discharge their contents in front of the boilers, several feet above the firing floor, into the proper spouts or burners in the top of the furnace.

Sawdust forms an important part of the fuel used in the Iron Mt. plant. It is collected from the various parts of the mill into a cyclone in the building nearest the power house, then it passes into a duct which takes it to storage bins in front of boilers 1 and 2. The bottom of these storage bins is just a little above the level of the burner hole in the top of the furnace. Five horizontal screw conveyors, made by the Ford Motor Co., take the sawdust a distance of about 4 ft. to a short spout which projects into the burner opening.

For burning fuel oil in an emergency, three Blake-Knowles oil pumps are installed, furnished by Worthington Pump and Machinery Corp., each pump mounted on the same base with its oil heater.

Boiler feed water for the plant is supplied by condensate from heating system, dry kilns, turbine exhaust

and various processes in the factory. Make-up water is taken from the Menominee River and on account of its characteristics must be passed through a hot-process, lime-soda water softener, furnished by the International Filter Co. Details of this water softener are given in Fig. 4. The softener is divided into two sections, one taking condensate, the other taking make-up water to be treated.

In the condensate section, which handles 264,000 lb. of water every hour, condensate from turbines and processes is pumped by a small booster pump to a heater on the third floor of the boiler house. Here it is heated with exhaust steam at 10 lb. gage pressure from the turbo-generators, the resulting mixture going into the boiler feed pump suction header below. A 14-in. pipe line, equipped with a Cochrane Multi-Ported atmospheric relief valve brings steam to this heater.

Into the second heater, raw water is pumped by a booster pump located on the ground floor. Exhaust steam from the 14-in. main enters this heater and the chemical is also introduced at this point. Lime and soda is the chemical used in this process. The water now passes into the large softener tank shown in Fig. 4 supported on the main boiler room floor.

The treated water is drawn from this tank by a motor-driven centrifugal pump, which forces it through the filter below, shown at the left of Fig. 4. It is then ready to pass to the feed pump suction header. Sludge from the softening tank is drained to the sewer by a quick-opening valve near the bottom of the tank as shown. Suitable expansion joints, relief valves, water level control floats are provided and the operation of the equipment is as nearly automatic as it is possible to make it. This section of the apparatus has a capacity of 150,000 lb. of water an hour. Since all this apparatus is above the boiler feed pumps, the latter have a suction head.

Two boiler feed pumps are installed. One is a 1000-g.p.m. Manistee Roturbo driven by a 250-hp. Westinghouse d.c. motor. The motor-driven pump is shown in Fig. 2A. The other pump is a 1500-g.p.m. Manistee Roturbo driven by a 400-hp. Curtis steam turbine, using steam at full boiler pressure. The pumps were supplied by the Manistee Iron Works, Manistee, Mich. Booster pumps for supplying water to the water softener, generator air washers and water mains are all Manistee Roturbos, driven by d.c. motors. Feed water level is adjusted by Copes regulators.

Two Dayton-Dowd fire pumps, both of 1500-g.p.m. capacity, are equipped to run at 2200 r.p.m., pumping against a head of 231 ft. One of these is driven by a Moore steam turbine, the other by a motor.

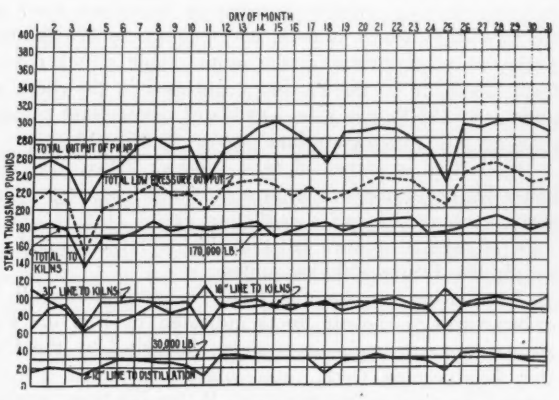


FIG. 8. DAILY STEAM CURVES FOR IRON MOUNTAIN PLANT, JANUARY, 1925

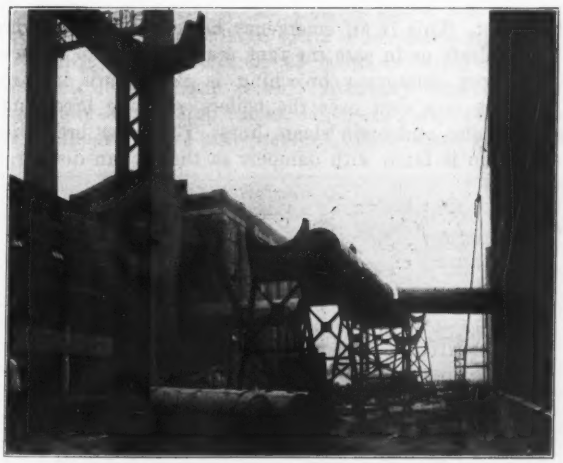


FIG. 9. CONSTRUCTION OF HORIZONTAL STACK, THROUGH WHICH FLUE GAS PASSES TO WOOD TREATMENT PLANT

Wood Treatment Plant Uses Flue-Gas for Drying

Since all the heat of the flue-gas is utilized in the wood treatment plant, no economizers are used in the Iron Mountain plant. The flue gas is drawn from the boiler through the damper at the bottom of the third pass, shown in Fig. 5, into a duct running vertically behind each boiler and thence through the horizontal duct to the wood treatment plant.

An induced draft fan, located on the ground floor under each boiler creates a draft of about 0.7 in. of water in the duct. In Fig. 3 these fans are shown below the boilers. They draw the flue-gas into the vertical ducts, from which it passes up to the horizontal duct, 10 ft. in dia., which carries it a distance of 600 ft. to the wood treatment plant. Pressure in this duct is kept constant by the Bailey automatic damper control.

Figure 9 shows this duct or horizontal stack, as the plant operators call it, under construction. Figure 1D shows how the breeching is brought up from the dust catcher at the base of the chimney and up the outside wall to connect with the horizontal stack. Figure 1D shows another breeching connecting to the stack above

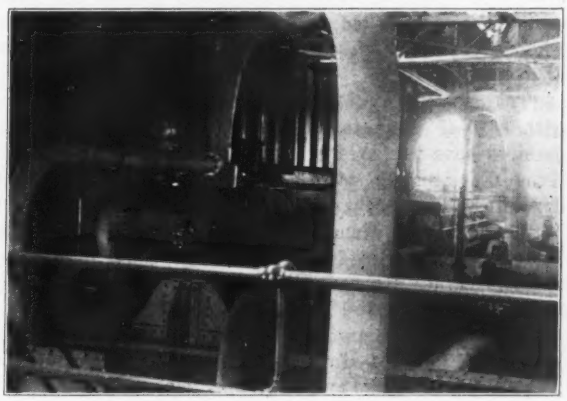


FIG. 10. TOP GALLERY IN BOILER HOUSE GIVES ACCESS TO UPPER BOILER DRUMS, MAIN STEAM HEADERS AND EMERGENCY BREECHING

this point. This is an emergency breeching for use with natural draft or in case the fans are taken out of service. This upper emergency breeching is also shown in Fig. 10, which is a view over the boilers, showing breeching, boiler drums and main steam lines. The lower breeching connection is fitted with dampers so that it can discharge

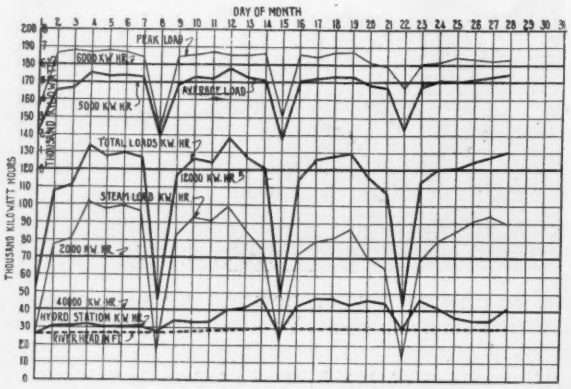


FIG. 11. DAILY ELECTRIC POWER CURVES FOR IRON MOUNTAIN PLANT, FEBRUARY, 1923

directly into the chimney, instead of the horizontal stack.

It will be seen from this that the chimneys merely act as auxiliaries to the horizontal stack, taking care of excess flue-gas that the wood treatment plant cannot use and acting as relief valves on the duct. These chimneys are 190 ft. high, built of radial brick by the Rust Engineering Co. They are 16 ft. 8¼ in. in diameter at the bottom and 10 ft. 11½ in. at the top. The breechings were furnished by the Connery Co., and the Ford sign by the Cusack Sign Co.

Turbine Room Was Designed for Two 5000-Kw. Units

In the engineer's office on the second floor of the boiler room, a bay window gives a view of the whole turbine room, the structural features and attractive appearance of which have been noted above. This room is 100 ft. long and 50 ft. wide, three walls being practically all window sash. At present three of the 750-kw. Ford turbo-generators are installed in the turbine room on temporary foundations erected on the reinforced concrete foundation that is all ready for one of the 5000-kw. machines that will ultimately be installed. Figure 2B shows two of the small units as now installed, viewed from the generator ends. Figure 2C shows a close-up view of the turbine end of one of these units.

Taking steam at 240 lb. gage pressure at the throttle, with a total steam temperature of 502.8 deg. F., these turbines have two pressure stages and run at 3600 r.p.m. Exhaust is at 10 lb. gage, at which pressure it goes to the dry kilns. The mechanism in the foreground of Fig. 2C is the governor. Generators are 3-phase, 60-cycle machines, generating at 4600 v. Although rated at 750 kw., these machines are normally operated to deliver between 900 and 1000 kw. at 100 per cent power factor.

These turbo-generator units were designed by the engineers of the Ford Motor Co. and built in the company's shops at River Rouge and Highland Park. The three units in Power House No. 2, the old power house, are of the same type and size.

It is the intention to replace these small units in the near future by two 5000-kw. turbo-generators, also being manufactured in the shops of the Ford Motor Co. These large units will generate at 13,200 v. This will eliminate the transformers used at present to step up from 4600 v. to 13,200 v. and will enable the steam-driven generators to be connected directly to the same bus as those of the hydro plant, as will be explained farther on. The high pressure steam piping and exhaust piping has been installed to serve the 5000-kw. units.

All steam-driven units exhaust into a line that carries the steam to the dry kilns, except for a small amount that goes to the water softener. If it is necessary to supply

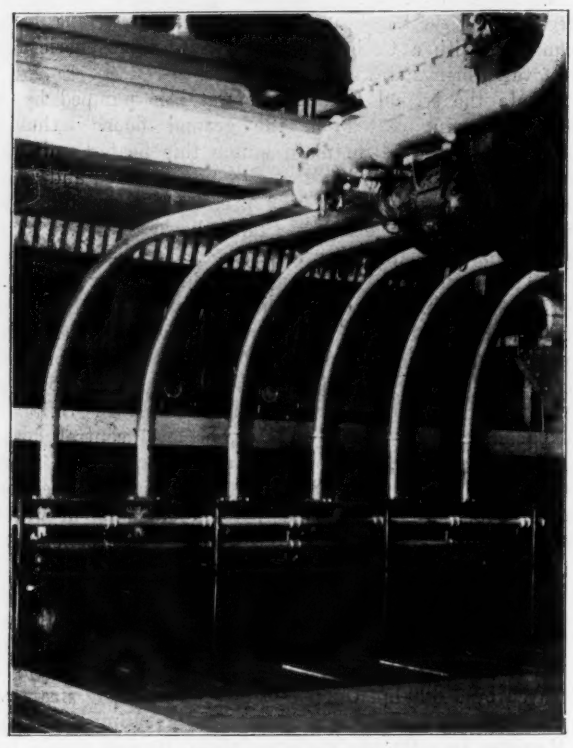


FIG. 12. TWO BOILERS ARE SUPPLIED WITH PULVERIZED FUEL, THE FEEDERS SHOWN ABOVE BEING INSTALLED ON NO. 4 BOILER

live steam to the factory direct, for any reason, it is passed into the low-pressure line through four two-stage reducing stations. Boylston reducing valves are used on the first stage which is from 250 lb. gage to 125 lb. and Kelley reducing valves on the second stage, which reduce from 125 lb. to 10 lb. Process steam used in the chemical plant is at 125-lb. pressure. Details of power plant piping, showing the reducing stations, appear in Fig. 15.

Excitation is furnished by a 100-kw., 230-v. Westinghouse d.c. generator, driven by a Westinghouse single-stage steam turbine through a reduction gear. This exciter, a view of which appears in Fig. 14, is large enough to supply the future 5000-kw. units.

Ventilating air for the 5000-kw. generators will be drawn through the air ducts indicated in Fig. 3. This air will pass through air washers, furnished by the Carrier Engineering Corp., and located as shown on the ground floor below the turbines. Water for these washers will be pumped over by the house service pumps mentioned above.

Motor-Generator Sets Transform A.C. to D.C.

Since all the motors driving wood-working machinery in the plant use d.c., motor-generator sets are employed to transform the generated a.c. to d.c. Four 1500-kw. and four 500-kw. motor-generator sets, all of General Electric Co. make, are in use in the mill at the present time. Two of these will ultimately be installed in the turbine room; one of the 1500-kw. sets is located there now, as shown in Fig. 2D, and a second similar unit is to be placed beside it. The other motor-generator sets are placed in substations located in the industrial departments.

On account of the fact that synchronous motors are used in these motor-generator sets, it is possible to adjust the excitation of the motors so that the power factor of the electrical system is 100 per cent. Excitation for the

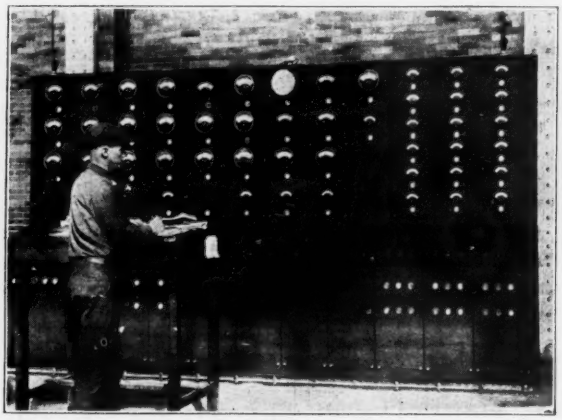


FIG. 13. ELECTRICAL CONTROL EQUIPMENT FOR ALL PRIME MOVERS, BOILER HOUSE APPARATUS AND OUT-GOING CIRCUITS IS CONCENTRATED AT THIS BENCH BOARD IN THE TURBINE ROOM

motors of these sets is taken from a ring bus system connecting with the various substations throughout the mill.

At present, the power generated by the 750-kw. turbo-generators is stepped up from 4600-v. to 13,200-v. by two 3000-kv.a. banks of transformers, furnished by the Pittsburgh Transformer Co. These transformers are of the air-cooled, oil-insulated type and are installed out of doors. This enables the present 750-kw. steam-driven units to be paralleled with those of the hydro plant, which generates at 13,200-v. When the large turbo-generators are installed, they will feed directly to the 13,200-v. bus, supplying the a.c. feeders to the motor-generators in the turbine room and substations. This will simplify the electrical system and will minimize the danger of electrical disturbances. All power plant wiring, feeders to the mill and switching equipment have been installed for 13,200-v.

In the turbine room is a control bench board, shown in Fig. 13, from which all the units in the plant are handled. This board was designed and built by the Ford Motor Co. engineers, for remote control of the switching equipment and circuit breakers, which are placed in a small room on the ground floor as indicated. Busses are isolated in compartments running along the turbine room wall on the ground floor. Westinghouse oil switches, type E-16, are used together with Westinghouse circuit-breakers. Relays, protective reactors and auxiliary equipment were supplied by various manufacturers.

Weston meters, made by the Weston Electrical Instrument Co., are used on the control bench board. Communication with the hydro plant is by means of a standard telephone circuit and the board is equipped with a complete load bulletin system. Auxiliary remote controls for motor-driven stop valves, fan motors and other boiler room apparatus are also provided. Each main generating

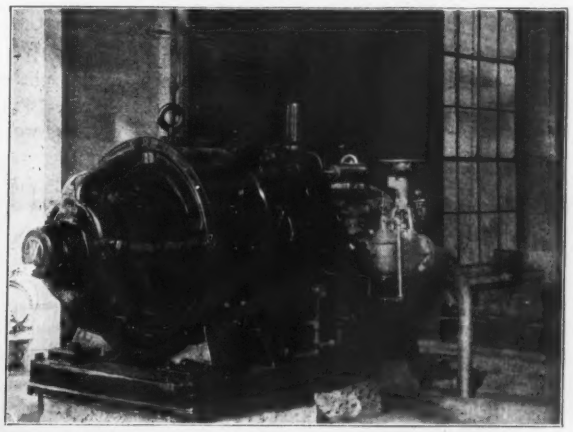


FIG. 14. THIS 100-KW. TURBINE-DRIVEN EXCITER WILL FURNISH EXCITATION FOR THE PLANT

unit has its individual recording meter board, carrying recording wattmeters, voltmeters and ammeters. One of these is shown at the right in Fig. 2B. The turbine room is furnished with a 30-T. traveling electric crane.

Operating in parallel with the steam plant described here is the hydro-electric plant, installed by Stone & Webster, Inc. Here a dam has been constructed, giving an average head of between 25 and 30 ft. Three hydro-electric generators are in use here, of 2250-kw. capacity each, or a total of 6750-kw. The water wheels are 3200-hp. units made by Wellman-Seaver Morgan Co. Generators are of Allis-Chalmers make, furnishing 3-phase, 60-cycle a.c. at 13,200 v. This is transmitted through an underground tunnel to the bus room in the new steam power house.

Excitation in the hydro plant is furnished by a 50-kw., G.E., d.c. generator on each hydro unit, belt driven from the main shaft of the unit. An auxiliary water-wheel driven G.E. exciter, of 65-kw. capacity, is also installed. The switchboard at this plant was designed and manufactured by the Ford engineers.

Comments on Operation of Plant

At the present time, boilers 1 and 2 are burning sawdust in suspension. On sawdust alone, these boilers have each turned out 90,000 lb. of steam per hr. for 3-day periods and 100,000 lb. per hr, for 6- or 8-hr. periods. The total load of 280,000 lb. per hr. has been carried by three boilers, when the fourth was shut down for washing or repair.

Figure 8 shows the steam production of the plant for January, 1925, and Fig. 11 the electricity produced by both the steam and hydro plants for February, 1925. The steam curves show that on January 15, for example, a total of 300,000 lb. of steam was produced by the new plant. Of this amount 228,000 lb. was in the form of low pressure exhaust steam, of which 170,000 lb. went to the dry kilns. The wood-treatment plant used 36,000 lb. of steam at 125 lb. pressure and the remainder of the low

pressure steam went to the heaters, water softener and heating system.

On the electric power curves, the total power produced on Feb. 12, for example, was 138,000 kw-hr. With a head of 29 ft. the hydro plant produced 40,000 kw-hr. of this and the steam units the remainder.

Number 1 Boiler Made Steam 92 Days After Construction Started

As noted above, an interesting feature of the power plant was the method of its construction. In July, 1923, the decision was made to build the plant. Drawings were made and detailed, material was ordered and on Sept. 1 the actual steel construction work was begun.

Figure 1A shows progress in excavating, concrete work and steel erection up to Sept. 30. One of the boiler drums is shown ready to be hoisted into place. On Nov. 3, 64 days after the start, No. 1 boiler appeared as shown in Fig. 1B. This shows the boiler all in place, part of the boiler brickwork and chimney, steel for the other boiler supports and some of the roof trusses in place. On Nov. 20, fires were started under No. 1 boiler to dry the brickwork, on Nov. 29 the oil pump was started and on Dec. 1, at 1:30 p. m., the boiler was operating at full pressure. In order to show in a photograph that the plant was operating, the furnace was purposely made to smoke, on Dec. 8, giving the result shown in Fig. 10. Figure 1D shows the completed plant as it appears at the present time.

While No. 1 boiler was being erected and operated, work was going forward on the concrete substructure, the pipe tunnels and the structural steel for the remainder of the building. The power plant was built around Boiler No. 1, which was operating all the time. No fatal accidents occurred during this process and those that did occur were of a minor nature which could not have been foreseen. The oil pump on No. 1 boiler was shut down for 5 min. on Jan. 21, 1925, for the first time after starting in 1923. The use of oil in this boiler was discontinued on Feb. 20, 1925, and pulverized coal substituted.

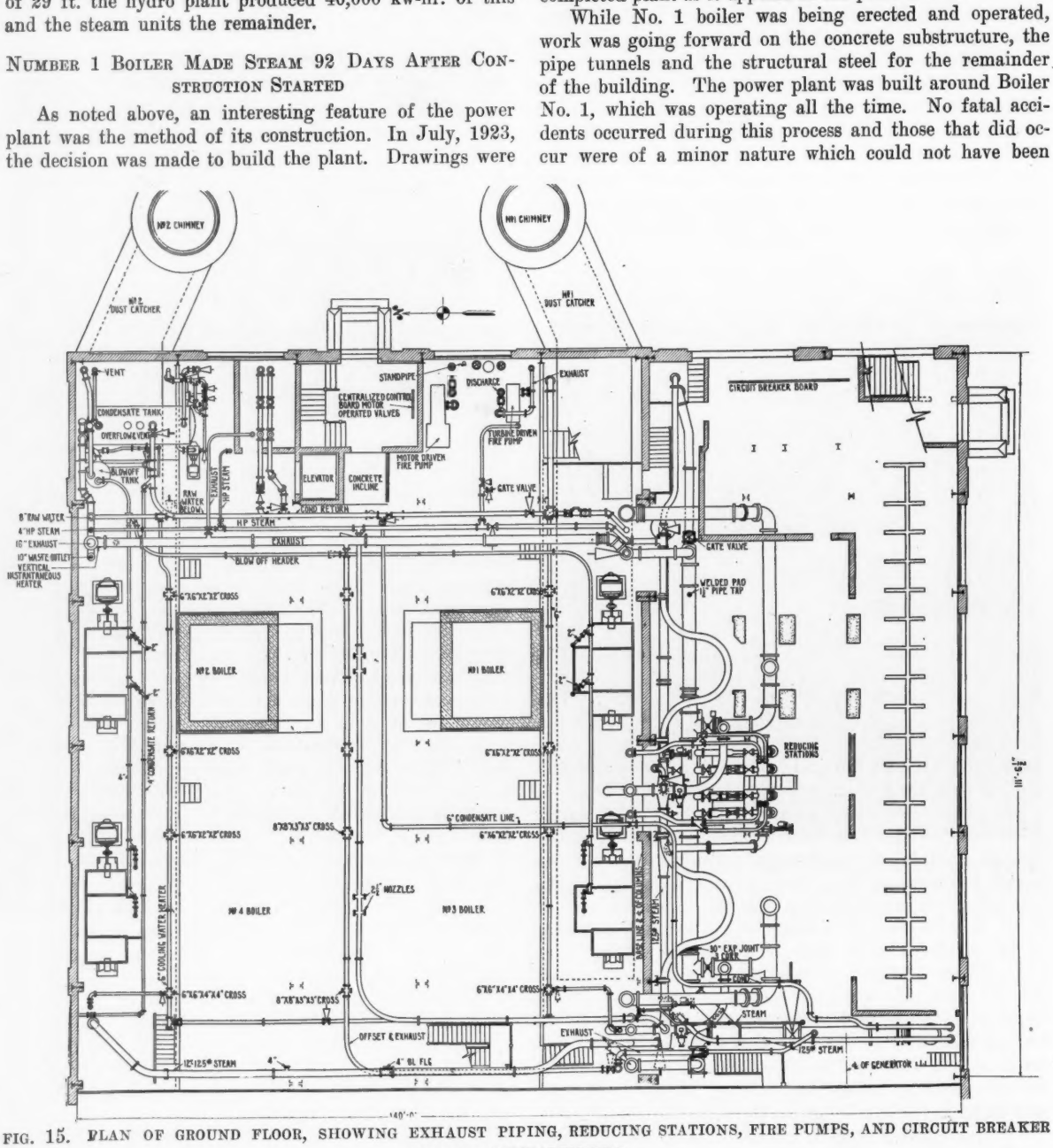


FIG. 15. PLAN OF GROUND FLOOR, SHOWING EXHAUST PIPING, REDUCING STATIONS, FIRE PUMPS, AND CIRCUIT BREAKER AND BUS COMPARTMENTS

Excavation work, concrete for the power house substructure and steel work were done by Worden Allen Co. The Rust Engineering Co. was contractor for the building brickwork, boiler settings, cut stone work, and concrete tile roof and roof covering. This company also did the general contracting of the building, such as floors, plastering, miscellaneous iron work, window sash, carpenter work.

Heating and Ventilating of Hudson Avenue

By Including Heating and Ventilating Systems in Original Station Design, Comfortable Working Conditions Were Secured Economically. By Charles S. Peace*

BESIDES PROVIDING an interesting study in the design and construction of a recent power station and its generating equipment, the new Hudson Avenue station of the Brooklyn Edison Co. presents a striking example of how the heating and ventilating systems of a central station can be embodied in the main design at its inception instead of being fitted into the remaining space, as is often the case, after the power generating apparatus is in place or in operation. The wisdom of the decision at Hudson Avenue to carry forward the design of the heating and ventilating systems parallel with the design of the station buildings and equipment soon became apparent; heating lines could be located to best advantage, space could be reserved for radiators, pumps and the like, and, natural draft stacks could be provided during building construction whereas, if omitted, future installations of fans and unsightly ducts would have to be made. Thus, in a great number of cases, future conditions were foreseen and provided for.

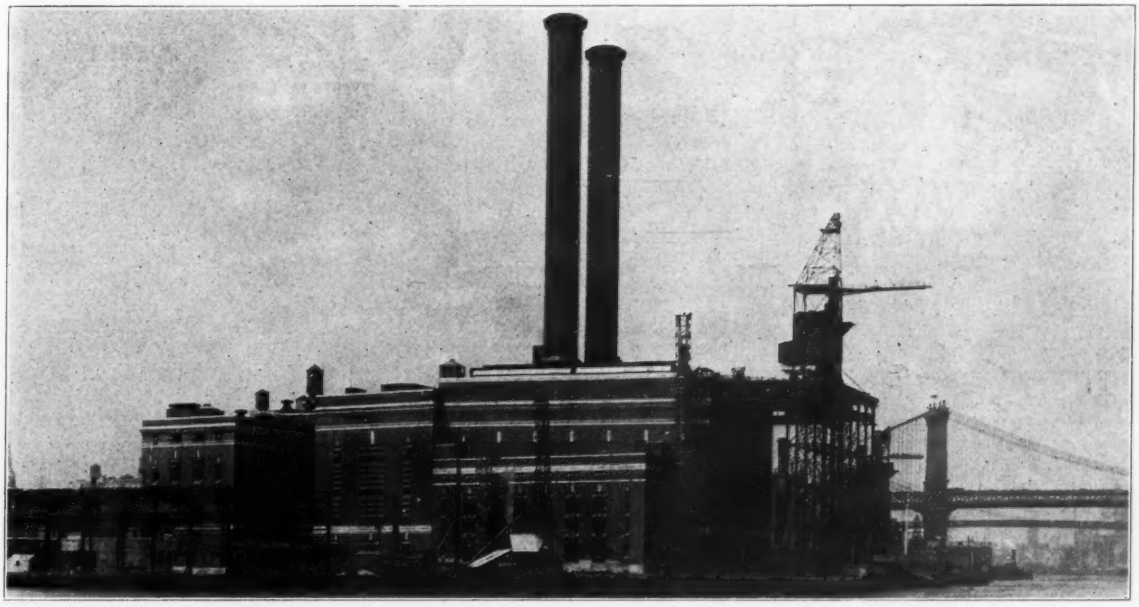


FIG. 1. HUDSON AVENUE STATION, SHOWING VENTILATING SASH, MONITORS AND VENT HOODS ON SWITCH HOUSE

Hudson Avenue station is located at Hudson Avenue and the East River, Brooklyn, N. Y., and is the largest of the three generating stations of the Brooklyn Edison Co., supplying the electrical load of the Borough of Brooklyn. The station will have an ultimate capacity of 550,000 kw. or over and to date three 50,000-kw. steam turbine generators have been installed as shown in Fig. 2, and an 80,000-kw. unit will be installed for operation in 1926. The present station buildings comprise about one-half the completed station and work is now in progress on the extension of the buildings to their ultimate size.

The buildings served by the heating system are the turbine room, boiler house, service building, switch house and frequency changer building. Figure 1 shows a general view of the station. In general, the building walls are of red brick and face brick averaging from 12 to 18 in. thick. The roofs are of concrete with waterproofing and a tile wearing surface, the windows are of plate and wire glass with steel and hollow metal frames and the doors are of hollow metal construction. In calculating the radiation requirements of the various rooms, the outside temperature was assumed to be 0 deg. F. and the following inside temperatures were assumed.

Heat transfer constants used for the various building materials were based on those given in the Warren Webster Co.'s book "Steam Heating." In the case of all the walls exposed to wind, except the south, 10 per cent was added to the heat loss as an exposure allowance.

Turbine Room	70 deg.
Boiler Room	70 deg.
Shower Rooms	80 deg.
Locker Rooms	70 deg.
Offices	70 deg.
Store Rooms	65 deg.
Toilets	70 deg.
Machine Shop	60 deg.

In calculating the heat loss due to air change, the method of computing the heat consumed in warming up the air leaking through the total perimeter of exposed ventilating sash and doors was used. This was done by computing the total perimeter of the ventilating sash and doors in feet and then multiplying by a factor of 124 B.t.u. for a 70-deg. temperature difference. This factor varies with the window construction and temperature difference. This method of computing the heat loss due to air change or air infiltration is much more accurate and much more logical than the usual method of assuming that the air in the room changes one or more times per hour

*Mechanical Engineer's Dept., Brooklyn Edison Co.

and computing the heat needed to raise this volume of air from the outside temperature to the room temperature. This air change method, when applied to large rooms, gives results which are extremely inaccurate and it should only, if ever, be applied to small rooms.

The estimating of the radiation required for offices, locker rooms, wash rooms and electrical apparatus rooms, presented no radical departure from the usual heating practice but, in the case of the large turbine room and the boiler house, the usual method of computing radiation could not be applied without modification. The present section of the turbine room is approximately 170 ft. long and 100 ft. wide with a ceiling height of about 80 ft. Experience at other stations had proved that to compute the total heat loss through all these large wall and roof

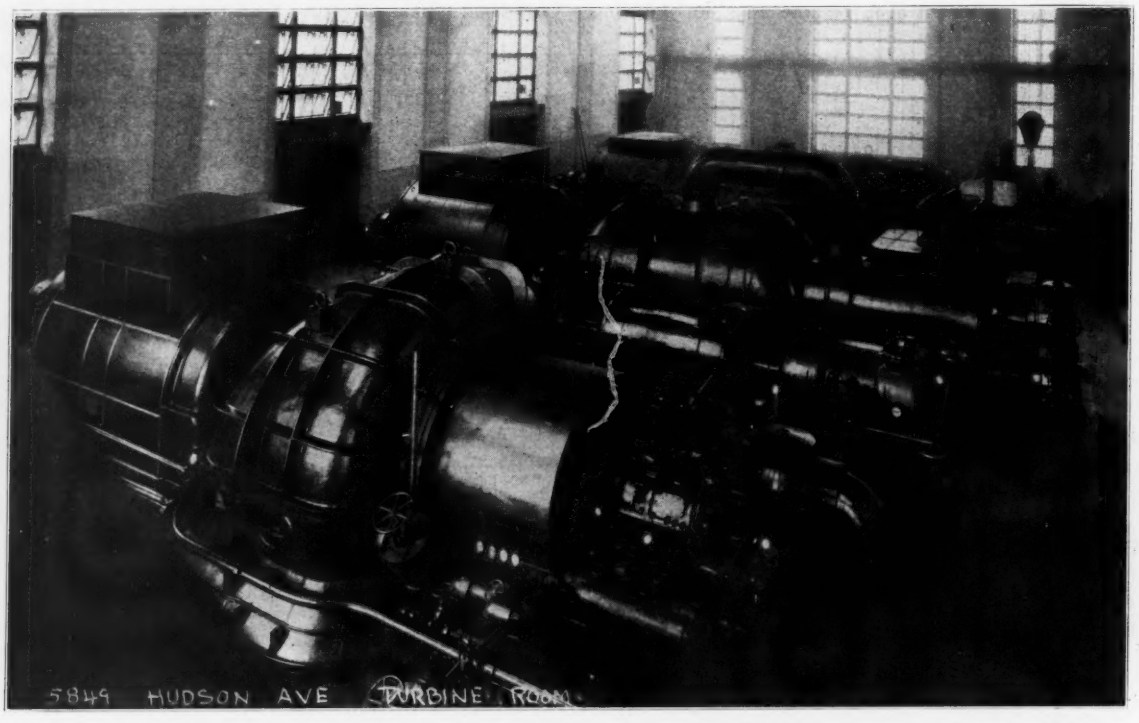


FIG. 2. CLOSED COOLING SYSTEM IS USED ON GENERATORS OF THE THREE 50,000-KW. UNITS AT HUDSON AVENUE

areas would give an amount of radiation greatly in excess of that required. Instead, an imaginary ceiling 30 ft. above the turbine room floor was assumed, the heat loss through the portion of the walls between the floor and this 30-ft. line was computed and the radiation was then proportioned to supply this loss. No heat loss was assumed through the imaginary ceiling. The heat radiated from the turbine generators was assumed to compensate for the air infiltration loss. The results obtained by this method of estimating the heating requirements have proved to be satisfactory during the past winter. The heat radiated from the turbine generators maintains a comfortable temperature where the men are working and the radiators installed around the walls offset the heat leakage through the walls and the large windows.

In the case of the boiler room a similar 30-ft. imaginary ceiling was assumed and the radiation proportioned to supply the heat loss through the walls and the glass areas as in the turbine room. Heating of the boiler room may seem paradoxical, since in most boiler rooms the problem in winter as well as in summer is one of ventilation and heat removal rather than one of heating, but in the Hudson Avenue station all the heat radiating surfaces have been carefully lagged and covered to prevent heat loss. The station is heated as far as possible, therefore, by a controlled heating system rather than by a random radiation of heat from all sorts of uncontrollable sources; this arrangement helps to carry out the intention of making the heat balance of the station as complete as possible. Radiation from the boiler settings maintains a comfortable temperature on the boiler room floor and the radiators around the walls offset the heat loss through walls and glass areas. It is interesting to note that the insulation of the boiler settings (22½ in. of fire brick, 3 in. of insulation and a ⅛-in. steel plate jacket) is so good that despite the high temperature prevailing inside, the outside jacket is hardly more than comfortably warm.

In the switch house, which contains the electrical switching apparatus and the auxiliary electrical apparatus, the radiation for the offices, control rooms, toilets, etc., was figured in the usual manner. In the rooms containing electrical apparatus giving off heat, allowance was made for this heat in figuring the radiation, using in all cases the minimum amount of heat given off by the apparatus. No heating is provided in the battery rooms.

Enough radiation is provided in the frequency changer house to maintain a temperature of 70 deg. inside with 0 deg. outside when the frequency changer is shut down This building houses a 35,000-kw. frequency changer which permits an interchange of energy between the 25-cycle system of the company, fed by the Gold Street station and the 60-cycle system, fed by the Hudson Avenue and the 66th Street stations. This machine, when in operation, gives off from 1000 to 2000 kw. per hour in heat, which is more than sufficient to heat the building.

Heating is also provided for the screenwell house to prevent the formation of ice around the screens. In the case of the coal towers and the ash crane, where the extreme exposure and the corrugated steel construction of the housings makes general heating difficult, local electric air heaters are installed near the operators.

The amount of radiation installed in the various buildings is given in the following table:

	Equiv. Sq. Ft. Radiation	Lb. Steam per hour
SWITCH HOUSE		
Direct radiation	4958	
Hot water tank	173	
Unit heater	2000	
Roof tank	44	
Total	7175	2152
FREQUENCY CHANGER BLDG.		
Direct radiation	928	278
SERVICE BUILDING		
Direct radiation	3554	
Hot water tank	350	
Total	3904	1171
BOILER HOUSE		
Direct radiation		
Basement	1071	
Operating floor	3339	
Roof tanks		
10,000 gal. house service	28	
10,500 gal. fire service	29	
TURBINE ROOM		
Direct radiation		
Basement	1106	
Operating floor	945	
Total	6518	1955
Grand total	18,525	5556

The hot water required for the wash rooms, toilets, etc., is furnished by two hot water tank heaters, one located in the service building and the other in the switch house. These heaters are supplied with steam from the heating mains through thermostat control valves. The condensate is discharged into the return mains during the heating season but arrangements have been made to waste it during the warm weather so that the vacuum pumps will not be required to be in operation to handle this small volume of condensate. Each of the four roof tanks, two on the boiler house and two on the switch house, is provided with a brass pipe coil to prevent the water from freezing. Steam is supplied to these coils from the heating mains.

Several Factors Influenced Choice of Steam for Heating Medium

After considering various types of heating mediums and piping systems, the following conclusions were reached: first, steam was chosen as a heating agent because a dependable supply from the main boilers was easily available; second, a vacuum type system was selected as it required smaller pipe lines, gave a more positive circulation than a gravity return system and also allowed the condensation in the return lines to be lifted from a lower to a higher elevation which could not be done with a gravity system. A steam pressure of 5 lb. per sq. in. was chosen as the operating pressure.

In general, the piping layout of the heating system consists of a 6-in. loop header running around the basements of the turbine room, boiler house and service buildings. To insure a continuous steam supply this loop header is fed at two points through reducing valve units with steam from the saturated steam headers of two of the main boilers of the station. Each of the two reducing units shown in Fig. 3 consists of two Leslie reducing valves, the first of which reduces the pressure from 250 lb. to 125 lb. and the second from 125 lb. to 5 lb. This double reduction was adopted because the pressure drop from 250 lb. to 5 lb. was considered too great to be made in a satisfactory manner with one valve. A bypass has been installed around each reducing valve and suitable gate valves provided to allow either or both of the reducing valves to be bypassed. The globe valves in the bypasses are used for hand operation by throttling the steam when the reducing valves are bypassed. Relief valves have been installed to protect the heating system against excessive pressures.

It is interesting to note that, since all the auxiliary apparatus of the station is motor driven, except three standby, steam-driven feed pumps, no exhaust steam is

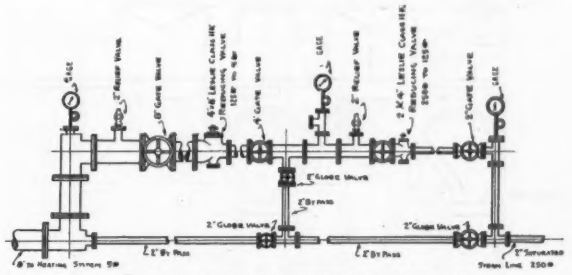


FIG. 3. DETAILS OF REDUCING VALVE UNIT

available for use in the heating system. The feed water of the station is heated by steam bled from the main units.

The loop header runs around the walls of the buildings, and the radiators in the turbine room and boiler house are fed directly from the main by connections running up to the radiators on the turbine room and boiler room floors and down to the radiators in the basements. The radiators on the four floors of the service building are fed by risers running up from the loop header. The steam supply to the switch house is furnished by a 6-in. low pressure line, running across a bridge over Marshall Street and feeding two main risers running up through the pipe shafts, one at each end of the building. The radiators are fed by branch horizontal mains running along the various floors. The layout of the steam piping in the switch house required careful consideration to clear the electrical apparatus. The low pressure main is used in preference to running a small high pressure line with a reducing valve unit into the switch house, thus removing the possibility of having a large volume of steam escape in the event of the line breaking. The heating lines are run so that they clear the compartments containing the high tension apparatus. The steam supply line to the frequency changer building is run in an underground conduit from the switch house.

Return mains follow in general the same course as the steam mains.

In the boiler house and turbine room basements, the location of the radiators made a continuous pitch of the return main back to the pump impossible. To overcome

this difficulty, the return main is in general pitched toward the corners of the buildings where lift fittings are installed to lift the condensation so that the return main can again pitch back toward the vacuum pump. If these lift fittings had not been installed, the high end of the return main would have to be elevated an undesirable distance above the basement floor. This feature of the vacuum type steam system is extremely convenient in power station work, as it allows the return mains to be easily carried under doors, down into pits and up again and around all sorts of interferences requiring a vertical displacement of the return main. The return mains from the turbine room, boiler house and service building are connected to a Nash Engineering Co. Type B, duplex vacuum pump unit, located in the turbine room basement. This unit has one separating tank and two motor-driven vacuum pumps, either one of which is sufficient to handle the system, with the other as a spare. The condensate is discharged by the pumps into one of the 45,000-gal. fresh water storage tanks located in the boiler room basement.

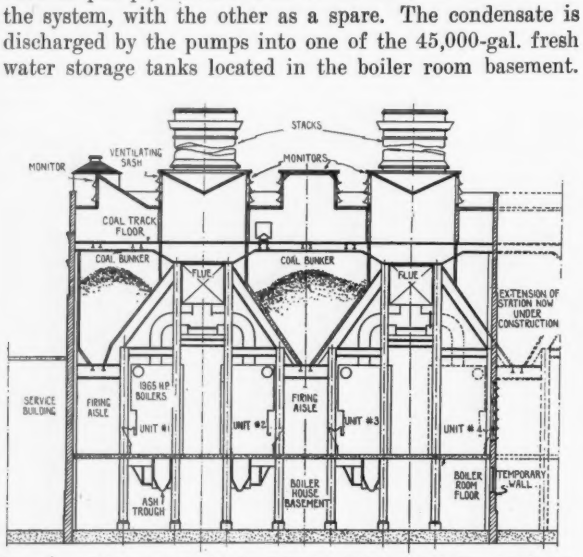


FIG. 4. CROSS SECTION OF BOILER HOUSE SHOWS SCHEME OF VENTILATION

The return mains of the switch house are run down the pipe shafts and connected to another Nash Type B duplex vacuum pump unit located in the switch house basement. This unit pumps the condensate back across the Number 1 bridge to the storage tank.

Steam lines were designed for a pressure drop of about 1 lb. per 500 ft. of run and the main supply and return lines carried approximately the following amounts of radiation:

Sq. Ft. of Radiation carried Main Supplies		Sq. Ft. of Radiation carried Main Returns	
1 inch	54	¾ inch	150
1¼ inch	130	1 inch	600
1½ inch	205	1¼ inch	1500
2 inch	426	1½ inch	3000
2½ inch	709	2 inch	6000
3 inch	1208	2½ inch	10000
3½ inch	1915	3 inch	15000
4 inch	2715		
5 inch	4947		
6 inch	8000		

All the steam and return mains throughout the station are covered with 85 per cent magnesia covering, recanvased with 8-oz. duck sewed in place.

Warren Webster & Co.'s Type W, modulation supply valves and the Model H sylphon trap are used on all the radiators. The radiators used in the turbine room, boiler house and switch house are the American Radiator Co.'s Peerless wall type and in the offices and control rooms, the Peerless legless two-column type is used.

Ventilating Systems Use Natural Draft Wherever Possible

The ventilating systems of the Hudson Avenue station have been designed to operate as far as possible with natural draft and air circulation and to eliminate in most cases the need of fans and other draft producing apparatus. Although these natural ventilation systems were more expensive to install than fan ventilation systems, as they require large ducts because of the small force available to move the air, they require practically no attention or maintenance and are entirely dependable and more or less self-regulating in their operation.

In the turbine room, large areas of ventilating sash are installed in the three exposed walls to provide inlets for cool air and a large monitor running the entire length of the room is provided in the roof to allow heated air to escape. The amount of heat discharged into the turbine room is relatively small, since most of the heat given off by the generators is absorbed in the closed cooling systems installed on each unit, leaving only the heat radiated from the units to be disposed of. The relatively small amount of heat to be removed, the large roof monitor, the cross ventilation and the large volume of the turbine room, all combine to make the working conditions in the turbine room quite pleasant. The cooling effect of the condensers in the turbine room basement tends to offset the heat radiated from the piping, while cross ventilation is secured by windows.

The ventilation scheme used in the boiler house is illustrated by Fig. 4, which shows a general cross section of the building. It will be noted that the sloping side overhead coal bunkers which run practically the whole width of the boiler house form vent hoods over the boilers, flues and uptakes and tend to collect the heated air and gases and discharge them through the large roof monitors. The large windows in the north and west walls of the building supply the air inlet so a continuous updraft is maintained to cool the building. Separate monitors have been provided to ventilate the coal bunkers and coal track floor, so that, in the event of a bunker fire, the smoke and gas may escape without affecting the remainder of the boiler house. This scheme works well and even in warm weather the room temperatures are not uncomfortable except in the immediate neighborhood of the uptakes. The boiler house basement is ventilated by the windows around the walls. The ashes from the boilers drop into closed, hydraulic ash troughs where a continually flowing stream of salt water carries them out to an ashpit on the dock. In this way the gas and steam from the ashes are prevented from escaping into the basement.

No special ventilation system is installed in the service building, which houses the locker rooms, offices, laboratories and shops, as ample window area is available.

The most interesting phase of the ventilation of the station is to be found in the switch house. The general electrical design of the station called for the isolation of the various electrical units as much as possible to localize any electrical trouble. These electrical restrictions led to the installation of three independent natural draft ven-

tilation systems shown on Fig. 5, the diagrammatic cross section of the building. The first system cools the auto-transformers located at A, which raise the voltage from the 13,200 v. generated to 27,600 v. The air passes in from the street, circulates around the radiators of the auto-transformers and passes up through the vent shafts to the roof. As the temperature of the auto-transformer compartments is limited to about 115 deg. F., the temperature difference available, with 90 deg. outside air, is only 25 deg. F., which necessitates large vent shafts in order to circulate sufficient air to remove the heat given off by the transformers under heavy load.

Each generator is connected to three transformers of 20,833 k.v.a. capacity each, in separate compartments, served by one vent stack of about 100 sq. ft. cross-sectional area and 90 ft. effective height. To reduce as far as possible the size of the stacks, care has been taken to make them as smooth inside as possible and to eliminate constrictions and other obstructions. The stack areas were computed from the usual chimney formulas. In winter, when a greater temperature difference is available, the rolling shutters at the air inlets are partly closed to prevent large volumes of cold air passing up the vent stacks and chilling the building. Fire dampers with fusible links have been provided at the bases of the vent stacks and fusible links have been provided on the rolling shutters at the inlets to close off the air supply and discharge in the event of a fire in the compartment.

The operating condition of the auto-transformer ventilating system in winter is shown by the following temperature and air measurements:

Volume of air circulated through all three compartments, cu. ft. per min.....30,600
Inlet temperature, deg. F..... 44
Average outlet air temperature, deg. F..... 57.5
Average velocity of air in stack, ft. per min..... 312

The second system ventilates the apparatus on the machinery floor B, Fig. 5. On this floor and on the ventilating floor below are located the motor generator sets, frequency changers, transformers and other auxiliary apparatus which supply the power to the electrically-driven auxiliaries of the station. The air enters from the street through the louvres on the ventilating floor, passes up through the openings in the machine bases and on out through the vent shafts to the roof. The louvres in the ventilating floor are shut and dampers in the vent shafts are closed in cold weather to maintain a comfortable temperature in the room.

Switch rooms C, Fig. 5, are ventilated by the third natural draft system. The three phases are isolated vertically on three floors and each generator has separate switch rooms. The operating mechanism is located overhead and passes down through all three floors and operates the switches simultaneously. The ventilating system carries off the heat given off by the generator and feeder reactors located in the switch rooms. The air enters from the street through the cold air corridor and passes up through the vent shafts. The reactors are cooled by drawing the air off from the vent shafts by a duct which discharges the air under the reactors. The circulation is created by returning the heated air to the same vent shaft to escape to the roof. It is interesting to note how a separate vent shaft has been provided in each switch room to remove the possibility of flame and smoke from an electrical failure in one room being carried through the vent shafts into the other switch rooms.

Fans mounted on the rotor of the 35,000-kw. frequency changer draw the air required for cooling from a large space under the machine and discharge the heated air from the top of the machine, whence it rises and passes out through the roof monitor. A large volume of air is required to cool this machine, because the heat given off is from 1000 to 2000 kw., depending on the loading of the machine.

Condensation of Moisture in Cold Incoming Air Is Prevented

In designing the ventilating system for these switch rooms particular attention had to be paid to the possibility of moisture condensing on the high tension apparatus and causing leakage and flashover troubles. Radi-

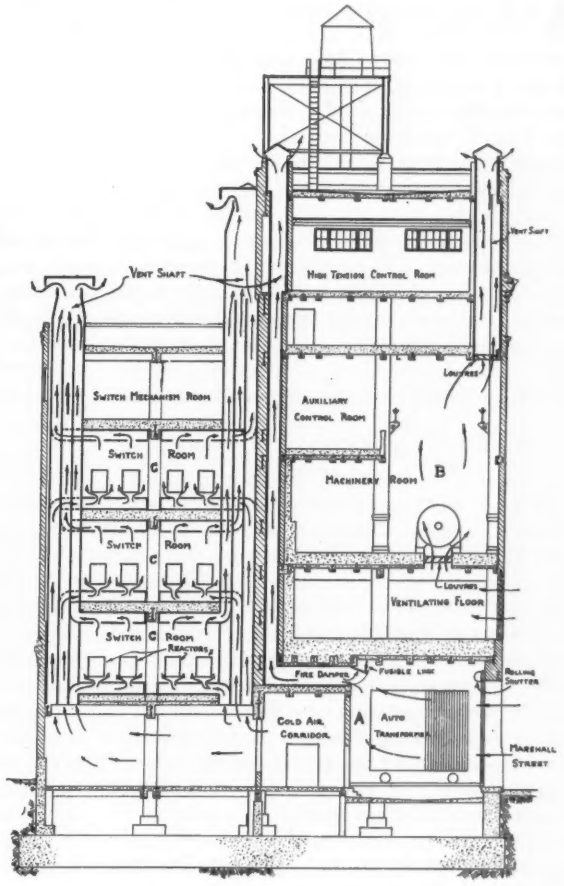


FIG. 5. NATURAL DRAFT VENTILATING SYSTEMS SERVE SWITCH HOUSE

ators have been installed in the cold air corridor to warm the incoming air and a unit heater provided near the inlet to heat a portion of the air to about 120 deg. F. This heated air mixes with the remaining cold air and, in combination with the heat given off by the radiators, warms all the air passing to the switch rooms. The unit heater consists of an Aerofin heating unit supplied with steam from the heating system, and a disk fan to blow the air through the heating unit. This apparatus is operated even in warm weather in order that the switch house surfaces will always be kept at a temperature above the dew point of the incoming air. Were this provision not

made, it might be possible in sudden changes of the weather for the switch house equipment to become so cool that it would act as a condensing surface and cause moisture to be precipitated from relatively warmer air.

In the Hudson Avenue station, this problem of condensation and its attending dangers was carefully considered and preventive features were worked into the original design. A ½-in. layer of Celotex was incorporated in the turbine room roof construction to prevent the underside of the roof becoming chilled and condensing any steam which might rise from the turbines. The concrete walkway which runs around the inside of the turbine room monitor prevents any moisture which forms on the glass from dropping on the machines. The precautions taken to prevent condensation in the switch house have been discussed earlier in this article.

Up to the present time, the heating and ventilating systems at Hudson Avenue have given satisfaction and have amply justified the care and forethought expended in their design and installation.

Notes on Steam Turbine Development*

SLOW ACTION OF SOME TURBINE GOVERNORS BLAMED FOR TRIPPING OF EMERGENCY GOVERNORS; EFFICIENT SMALL TURBINES DESIRED

AS SOME member companies of the National Electric Light Ass'n have had difficulty with steam turbine governors, the subject has been taken up by the Prime Movers Committee. The main control governor on certain turbines does not shut off the steam quickly enough when the load is suddenly removed from the turbine. This allows the turbine spindle to increase in speed until the emergency governor functions and the overspeed valve is closed. Such action delays the return of the turbine back into normal service and causes a serious interruption in the plant operation. This question of governor control was taken up with the large turbine manufacturers and statements have been received from these companies. It would appear from certain statements by the manufacturers that this matter deserves further attention from their designers before the trouble will be completely overcome.

STATEMENT BY THE ALLIS-CHALMERS MANUFACTURING CO.

"It is an unusual occurrence to hear of an Allis-Chalmers machine tripping out due to overspeeding on account of losing load. In such cases worn pins and bushings in the governing mechanism would be expected or the valve spindles covered with a deposit or scale carried over in the steam. Possibly improper spindle gland packing or a gland pulled up too tight might contribute to the difficulty. If this difficulty should be present with the mechanism in proper operating condition, it could readily be corrected by increasing the foot pound capacity of the relay cylinder and enlarging the oil piping to and from the oil relay cylinder. At the same time the necessity for clean steam should be emphasized."

STATEMENT BY THE GENERAL ELECTRIC CO.

"The speed control governors and emergency overspeed governors on General Electric turbines are so adjusted with respect to each other that the full rated load may be suddenly removed without causing sufficient momentary overspeed to actuate the emergency governor.

"This statement should apply to all turbines manufactured by the General Electric Co. and if there are any isolated cases where trouble is being experienced we would appreciate having them called to our attention."

"It should be recognized that in power house practice turbines are generally relieved of load following a short circuit which exists for a period of time in accord with the action of the time limit relays, so that prior to the opening of the circuit breaker, all admission valves are open and the turbine is sustaining its maximum load, all chambers connected to the turbine steam path being filled with steam at the maximum pressure. Therefore, the regulating apparatus has to be quite good to prevent the small amount of overspeed necessary to trip the safety stop. This amount of overspeed is, however, small—smaller than the 10 per cent above the normal speed at which the safety governor is set. For stable governor operation, it is necessary that the governor itself has not less than 3 or 4 per cent variation between no load and full load. It is customary at all times to maintain the frequency at its normal value at all loads. For example, a 60-cycle turbine running at full load will be running at normal speed. If the load were removed sufficiently slowly so that it was at all times under strict control of the governor, by the time no load was reached the frequency would rise to about 62.4 cycles—still under perfect control of the governor—beyond which it is only required that the turbine speed reach 5.8 per cent higher before the safety stop would operate. There have been a few instances where there have been complaints of of load, but the desirability of the governor precluding this the safety stop operating upon the turbine being relieved degree of overspeed is fully recognized and generally speaking, this has not been difficult to accomplish.

"It would be considered entirely proper for purchasers of turbines to specify that the regulating mechanism should be capable of controlling the speed so that the safety stop mechanism will not be called upon to operate in the event of the turbine suddenly being relieved of load, provided the safety stop mechanism is adjusted to operate at 10 per cent overspeed and there is no extraneous apparatus that will furnish steam to the turbine from sources other than the governor controlled valve mechanism."

EFFICIENT SMALL STEAM TURBINES

Desire for increased plant efficiency has created a need for more efficient small steam turbines for auxiliary use in the smaller power stations and also when certain steam driven auxiliaries are desired in the larger stations. Such auxiliaries as boiler feed pumps, house turbines, exciters and dual drives for circulating and condensate pumps, are units that might be furnished with more efficient turbines. The demand for higher efficiency is based on the fundamental idea that the heat head in the steam should be utilized at the highest possible efficiency in every case within the limits of reasonable cost and that such utilization will result in an improvement in station economy. The decreases in steam consumption that are sometimes possible by improvements in design are quite large. It would, therefore, seem timely to have turbine manufac-

*From a serial report of the Prime Movers Committee (1924-1925) of the National Electric Light Ass'n.

turers study the possibilities of improvement in the efficiency of small turbines and to submit figures to engineers covering such improvements and the additional cost to effect them. Certain manufacturers are already alive to the possibilities of such developments. Comments of other manufacturers indicate that they recognize the possibilities but hesitate to make the developments on account of the fact that small units are usually purchased on a strictly competitive basis of first cost with economy a secondary consideration. If engineers will demand higher economy in such units, the manufacturers will provide them.

STATEMENT BY THE ALLIS-CHALMERS MANUFACTURING CO.

"It has been our experience through contact with power plant engineers, that the subject of a reliable and economical drive for the different essential continuous service auxiliary apparatus is still in the controversial stage and that opinions differ greatly, with some indication that the small turbine for this service may again find favor. The use of the electric motor for auxiliary drive has, no doubt, been extended through the rapid development of feedwater heating by interstage extraction of steam from the main turbine and to a lesser extent by the use of direct driven auxiliary generators. These two arrangements have not only increased the application of the electric motor to auxiliary service, but have tended to supplant the steam driven house generator set as a source of power for the electrically driven auxiliaries.

"There is no question but that the smaller size turbine for direct connection to the larger and essential auxiliaries can be vastly improved as to both economy and reliability if there proves to be a real demand for it. The turbine designer, if given the opportunity, can meet such a demand with a small power turbine which will be equally or more reliable than the main unit which it is serving. Further, this small turbine can be designed with an efficiency which will make it a satisfactory apparatus for a modern plant.

"So far as we know, the power plant engineer has not been sufficiently committed to the use of the small steam turbine in large modern plants to warrant the work which is necessary to the development of even tentative detail designs, although there are some indications that it will be practical to undertake such work in the near future. To take full advantage of the possibilities in small turbine design and its application to the driving of power house auxiliaries it will be essential to make full use of reduction gearing of proportions which have proved to be good for continuous service."

STATEMENT BY THE GENERAL ELECTRIC CO.

"The existing line of General Electric auxiliary drive turbines is very flexible in design and by increasing the number of stages and running the turbines at high speed geared to lower speed auxiliaries as good efficiencies as are commercially desirable may be obtained."

STATEMENT BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

"In the past the Westinghouse Electric & Manufacturing Co. has built a large number of simple and reliable turbine drives. With the advent of stage bleeding of the main turbine, electrically driven auxiliaries have become more common practice, and it is felt that these have been justified, particularly as they eliminate the heat and mess incidental to piping and drains of steam driven auxiliaries. More economical auxiliary turbines may of course be produced if there is a demand for them; the higher economies naturally being secured with greater complexity, more stages, etc., which cannot but have their effect upon reliability. Either the turbine drive or the motor itself, as well as the lines of the auxiliary power house system, if properly designed, would have satisfactory reliability. There are at least one or two systems available which will maintain the auxiliary electric system immune from outside line disturbances.

"The Westinghouse Electric & Manufacturing Co. is not at this time giving attention to the development of high efficiency turbines for auxiliary drives, but would do so if brought to believe there was a market for that kind of apparatus."

Bonus Paid on Boiler Meter Record

IN THIS SYSTEM, FIREMEN ARE PAID FOR PERFORMANCE DURING THEIR SHIFT, A GRADUATED BONUS ACCORDING TO HOW NEAR THE METER RECORD COMES TO PERFECTION. BY SAMUEL E. BALCOME*

IN THIS article will be described the bonus system used in the boiler room, at the factory of the Graton & Knight Mfg. Co. It has been in use for over 2 yr. and, so far as can be seen, is a success, in that it secures the best operation of the fires and obtains good results.

With many systems of bonus for boiler room operators the trouble is that there are ways to beat them and receive the bonus without giving results which should be expected. The writer does not believe in putting one man against another, as a rule, in the business of burning fuel and making steam because it has a tendency to develop hard feelings among them and, instead of working all together for the common good, they spend their energy in trying to find ways to make their own results right at the expense of the men on the other shifts. The writer is speaking of boiler rooms where boilers are in operation 24 hr. per day and where two or three sets of firemen are in attendance. With the system here described, the only objection heard so far from any of the firemen is that it is too much like piece work.

This system is based on the operation of the Bailey Boiler Meters, which are taken care of by one man who does not participate in the bonus, and who, of course, is interested only in having the meters right. These meters, like all boiler room measuring apparatus, require a certain amount of attention to be kept accurate. This is always necessary in regard to meters, recorders, etc. because, if they are allowed to get out of order so as to register incorrectly, they give a wrong impression.

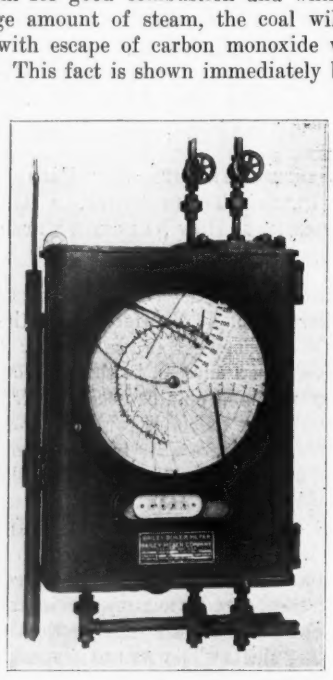
For the benefit of those readers who are not acquainted with the Bailey Boiler Meter, a description and explanation of its operation will be given. This meter records and totalizes steam flow, records air flow and flue gas temperature. The steam flow pen traces a red line and shows the rate of steam generation and the air flow pen traces a blue line and shows the amount of air supplied for combustion. The relation of the steam flow and air flow records shows the combustion conditions, that is, whether the correct amount of air is supplied for combustion. When the correct amount for maximum economy is supplied, the steam flow and air flow pens are together, regardless of the

*Chief Engineer, The Graton & Knight Mfg. Co.

rate of steam flow. An excess of air is shown when the air flow pen is above the steam flow pen. A deficiency of air is shown when the air flow pen is below the steam flow pen.

All regulation of the air supply is in the hands of the boiler operator and is accomplished by regulating the stokers and also the drafts. Automatic apparatus is used as much as possible, such as balanced-draft damper regulators and steam pressure regulators, and it is the first duty of the men to control these so that the pens will remain together as nearly as possible.

It is easily seen that, if the fires are allowed to become too thick, it will be impossible to force air enough through them for good combustion and while generating quite a large amount of steam, the coal will be burned wastefully, with escape of carbon monoxide which means quite a loss. This fact is shown immediately by the boiler



BOILER METER AND RECORD AS USED FOR DETERMINING BONUS PAYMENT

meter, the air pen dropping and tracing a line below the steam pen, which shows the fireman just what to do. This is corrected by cutting down the coal feed long enough to bring the fires to the proper thickness, which will also be shown on the boiler meter chart. Thus, the job of the operator is to keep the pens together. Poor control of drafts will also cause a loss which will show on the charts.

The following schedule, which is posted in the boiler room, shows what the men receive per week according to the results shown by the meters.

"A bonus will be paid to firemen according to per cent of proper operation of boilers as shown by Bailey Meters. Red and blue lines running steady and close together will be considered high per cent, but wavering lines and lines separated will be considered low per cent. Charts will be measured by a planimeter of suitable type for circular charts and bonus will be paid as follows: 90 to 100 per cent perfect, $5 a week; 80 to 90 per cent perfect, $4 a week; 70 to 80 per cent perfect, $3 a week; 60 to 70 per cent perfect, $2 a week.

1. At least two boilers (when load is sufficient) shall be run at 130 per cent of rating, 70 per cent of time.
2. Fires must be left right for each shift.
3. Feed water must be regulated evenly as this has an effect on Bailey meters.
4. Firemen must report anything needing repairs or adjustment."

Percentage of perfect operation is determined by the use of a radial planimeter which is used to trace each line separately. When tracing the lines, the planimeter pen is made to follow, first, the inside line regardless of whether the color of the line is blue or red, sometimes being on the blue line and sometimes on the red, which gives a figure proportional to the area within the line. Next, the outside line is traced over and reading taken, which corresponds to the value of area inside of that line. Incidentally, these planimeter readings are referred to a table which converts the reading to one applicable to the charts we are using. The reading from the inside line divided by the reading from the outside line will give the per cent sought for. It is easy to conceive that if the lines are exactly together during all of the 24 hr., the per cent found would be 100 and the bonus would be $5 a week extra but this, or even 90 per cent, has not been attained as yet, although sometimes they come very near to it. Most of the time, $4 is the amount received.

When this plan was started, it was thought that the planimeter could be traced over the red line first and then over the blue line but it was seen that, as these lines cross each other many times, it would be possible to get 100 per cent yet derive results which were not good, as these pens must be near together all of the time in order to work correctly.

By keeping the fires regulated as to proper amount of air for good combustion, the carbon dioxide content in the flue gases holds up from 11 to 13 per cent, and since the meters were installed and the bonus system started, we have been able to maintain that high per cent; whereas, before the meters were used, the analysis of the flue gas would give about 6 to 9 per cent of CO_2. The plan thus shows an appreciable gain in economy in burning the coal, a saving which much more than pays for the bonus paid to the firemen.

It should be stated here that the Orsat flue gas apparatus is used periodically to check up the meters, as they are set so that, when properly operated, flue gas analysis should show at least 12 per cent CO_2 with no CO. The gas is drawn into large collectors slowly, the time for collecting one sample taking 2 or 3 hr., thus giving average results over that whole period.

This system of bonus and boiler regulation has been effectual in acting as a monitor over the firemen and, after getting familiar with the meters, the men rather like them. The work has been but little harder while results attained are quite satisfactory.

AT THE FIRST meeting of the recently organized Structural Steel Board of Trade, Inc., of New York, it was decided to abandon the practice of submitting per pound prices on structural steel contracts, and to substitute the lump sum bid on all contracts. Another conclusion called for complete designs for intelligent estimating before any bids would be furnished. The change in policy became effective November 1, 1925.

BLOWOFF DITCHES should be kept clean and dry. Too many plants have blowoff ditches behind the boilers that are filled with water or mud which rusts out the blowoff lines.

Care and Upkeep of Surface Condensers*

METHODS OF CLEANING TUBES, OVERCOMING TROUBLE DUE TO AIR IN-LEAKAGE AND CIRCULATING WATER LEAKAGE IN SURFACE CONDENSERS

CAUSES OF LOW vacuum in surface condenser operation may be listed under three headings: dirty tubes, air in-leakage and insufficient cooling water. Air in-leakage is indicated by a combination of poor vacuum and under-cooled condensate. Insufficient cooling water will be indicated by poor vacuum and by high outlet water temperature, and dirty tubes by poor vacuum and low outlet temperature.

Deposits of dirt, slime or scale on the tubes is one of the most common sources of trouble and unless the circulating water is exceptionally clear and free from scale forming impurities is one that must be constantly guarded against. The various types of deposits may be listed as follows:

1. Silt, sand or other suspended matter. High water velocity helps prevent accumulations of silt.

2. Organic deposits from sewage laden waters. Such deposits are often tough and hard to remove.

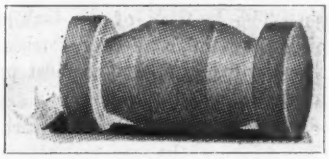


FIG. 1. RUBBER PLUG USED IN CLEANING CONDENSER TUBES. IT IS SHOT THROUGH THE TUBES BY COMPRESSED AIR OR BY WATER PRESSURE

3. Vegetable slime. Certain low forms of vegetable life found in polluted waters will coat the interior of condenser tubes with a thick slime that is troublesome because of its quick growth. There has been some experimentation in England on preventing this growth by a chlorine treatment of the circulating water similar to that employed for many city water supplies.

4. Scale. Usually calcium carbonate or sulphate. Sea water and hard water from limestone districts offend in this manner. Sulphate scales are usually hard and laborious to remove.

5. Iron and aluminum hydroxides. These form a gelatinous deposit similar to and often associated with the organic deposits.

METHODS OF CLEANING TUBES

There are many methods of cleaning condenser tubes, individually useful according to the type of deposit. Silt, or loose sediment, can be dislodged by a jet of high pressure water directed through the tube. Suspended matter can often be removed from a compartment type condenser by shutting down one of the compartments, using the full circulating water capacity through the other compartment, thus producing a very high water velocity to sweep out the suspended matter.

One of the simplest means for removing scale, especially in waters which contain a large proportion of organic matter combined with a reasonable amount of hard mineral matter, is to drain the water side of the condenser and bake the scale off by admitting steam into the steam space of the condenser. Many types of scale treated in this manner break up into a pulverulent dust or crack off into small flakes which can readily be washed out either by the normal use of condensing water or by the use of high pressure water jets through individual tubes.

Soft rubber plugs shot through the tube under air or hydraulic pressure will remove soft deposits. Time may be saved by stationing a man at the other end to collect the plugs and shoot them back. Special air guns have been developed which not only shoot the plugs through the tubes, but also automatically insert the plugs. This is an exceedingly quick method of cleaning tubes and, used at frequent intervals, is often sufficient to keep the tubes in good condition. Some types of tough deposit such as iron hydroxide will pack under the influence of ordinary rubber plugs and form a thin tough coating with a high resistance to the flow of heat. A plug formed by driving a nail through leather washer is efficient, but is difficult to insert into the tubes. If the deposit is unevenly distributed, the plug should be shot through in such a direction that it will have to push the deposit the least possible distance.

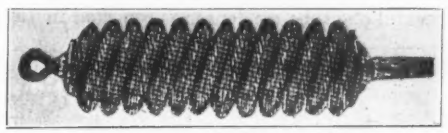


FIG. 2. SCRAPER TYPE TUBE CLEANING BRUSH

FIG. 3. WIRE BRISTLE TUBE CLEANING BRUSH FOR SOFT DEPOSITS

Harder deposits require the use of brushes or scrapers. Hard packed silt or sand, soft scale and vegetable slimes can be removed with the brush shown in Fig. 3. Harder deposits, such as mineral scale or vegetable matter which has become baked on, require the use of the scraper brush shown in Fig. 2. This brush will not injure the tube and will retain its effectiveness until entirely worn out. There is enough give to the bristles to permit passing a slight constriction in the entrance of the tube.

Hard calcareous scales that are difficult to remove by other means are easily removed by a weak solution of hydrochloric acid circulated through the tubes. There is some danger of accelerating tube corrosion by this means, but if the acid is applied intelligently and is thoroughly flushed out, the danger is negligible.

Acid treatment should not be used if the circulating water contains a large amount of chlorides, as such water is corrosive and a small amount of scale such as would be left by mechanical cleaning is necessary to protect the tubes.

Condenser tube cleaners, similar in principle to boiler tube cleaners, are made by most of the boiler tube manufacturers and will remove scale efficiently. Care should be taken in their use, however, not to injure the soft copper

*Abstracted from the Wheeler News, published by the Wheeler Condenser and Engineering Co.

or brass tubes. Especial care should be taken to see that no constrictions due to improper packing exist. The chief difference between these cleaners and the boiler tube cleaner is that, due to the small size of the tube, the motor can not be contained in the cleaner head and it is necessary to use an extension shaft to the cleaning heads.

An effective method of removing extremely tough or hard scale is the sand blast. About one quart of clean dry sand should be used for each tube. One operator can clean about 100 tubes an hour. This cleans the tubes thoroughly but is a tedious and disagreeable job. It is therefore usual to employ some other less effective means of cleaning until the residue left in the tubes after each cleaning becomes so thick as to be troublesome. Comparative results obtained from the use of different methods of cleaning tubes on an experimental one tube condenser as reported in 1924 by the

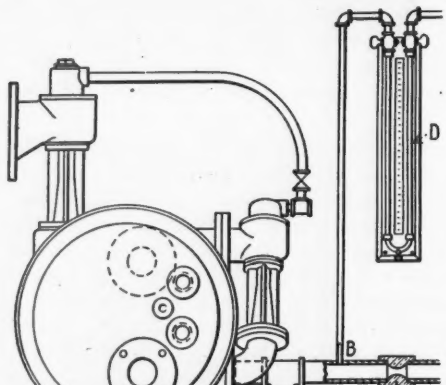


FIG. 4. AIR METER. THE BACK PRESSURE ON THE SMALL ORIFICE INDICATES THE VOLUME OF AIR BEING REMOVED BY THE STEAM JET AIR PUMP

Prime Mover's Committee of the N. E. L. A., are shown in Fig. 5.

Frequency with which tubes should be cleaned depends upon local conditions. Scale is allowed to accumulate until the loss of vacuum due to lower rate of heat transfer causes enough loss to warrant the expense of cleaning the tubes.

Oil from reciprocating engines or salts from the boilers are sometimes present in exhaust steam and will coat the outside of the tubes. To clean the steam side of the condenser tubes, use about 1½ lb. of sal soda or sodium carbonate per 100 sq. ft. of surface. Fill the condenser with water, leaving a vent open on top, and introduce a one-inch steam line at the bottom; let boil for 2 or 3 hr. The solution should not be stronger than stated, as it will attack the tube packings.

Circulating Water

The amount of water passing through the condenser should be calculated periodically. This can be determined approximately from the load and the rise in temperature, as follows:

$$\text{g.p.m.} = 1.89\ S \div Tr$$

in which g.p.m. is the gallons of circulating water per minute, S is the steam exhausted to the condenser in pounds per hour, and Tr the rise in temperature of the circulating water in its passage through the unit. If the amount of water is insufficient, look for air leakage in the pump, stuffing boxes, and following that, investigate the condition of the piping and of the inlet tube sheet. Where the circulation is syphonic, both the discharge and suction pipe must be well submerged. With centrifugal circulating pumps, special attention must be given to the water seal of the stuffing boxes. The sealing water should be under not less than 15 lb. pressure.

Air Leakage Into Condensers

Air, by blanketing the steam side of the tubes, greatly lowers the coefficient of heat transfer and decreases the vacuum. Excessive air in-leakage is indicated whenever a low vacuum, cold condensate and a normal rise in temperature of the cooling water are combined.

Little air enters a condenser directly with the steam, the larger part leaking in through joints in the condenser, small piping and turbine casing. Constant check should be kept on air in-leakage wherever possible, by the use of an air meter. Such a meter will measure the air discharged by any steam jet air pump with an after condenser and indicate the air discharged, so that any increase can be immediately seen. The location of the leak may be determined by going over the condenser, turbine and piping carefully with a lighted candle. The most probable points for leakage are as follows:

1. The condenser joints. Periodic inspection should be made as temperature changes and vibration from the turbine or pumps will gradually loosen the bolts. If, due to shortage in the condensing water or for other reasons, the turbine is run with low vacuum, over-heating the condenser, the joints of the condenser shell should be gone over carefully. The expansion and contraction will loosen the bolts and the heat will soften the packing.

2. The low pressure seal on the turbine. Carbon rings should be kept in good condition and an ample supply of sealing water or steam maintained.

3. The turbine casing. At periods of low load, the pressures in the lower stages of the turbine are less than at high load. The resulting temperature changes make the joints in the casing hard to keep tight.

4. Low pressure bleed connections. Connections from the turbines to bleed heaters, in which the pressure is less than atmospheric, are often sources of air leakage, especially when the heater is vented back to the condenser.

5. The exhaust connection between turbine and condenser. This is usually inaccessible and difficult to inspect.

6. The stuffing-boxes of the hot-well pump. Air in-leakage here can be eliminated by using the Wheeler pressure sealed hot-well pump.

7. The atmospheric release valve. The release valve should always be water sealed.

8. Vacuum piping. All piping under vacuum, including the exhaust pipe, should be regularly inspected. It is common practice for pipe fitters to use ring gaskets, extending only to the bolt circle, instead of gaskets the full width of the flange. While ring gaskets are satisfactory for pressure lines, the full gasket should always be used for vacuum piping. Leaks from this source are almost impossible to detect as the gasket is sucked in. Small pipes from the condenser to evaporator condensers or auxiliary condensers, for priming pumps, or for laboratory purposes, are always a source of trouble. While the amount of air

to be removed may be so small as to be inappreciable, such small pipes are always extremely difficult to keep tight and the leakage may easily be so great as to more than pay for the installation of separate steam jet air pumps or ejectors for these purposes.

The small air leaks which remain after inspecting the gaskets, tightening bolts, etc., may often be stopped by the use of a heavy asphaltum paint, applied liberally along all joints. This asphaltum paint is also useful for stopping up porous places in turbine casings, condensers and piping.

If the symptoms of air in-leakage, low vacuum and low condensate temperature are present but no leakage found, the trouble may be with the air pumps. About the only thing which can happen to a Wheeler steam jet air pump is for particles of scale carried by the steam to clog up the nozzles. These can easily be inspected and cleaned. The operation of the reducing valve in the steam line of the air pump should be inspected periodically, and if raw water is used in the steam jet air pump inter and after condensers, these may require cleaning.

Condenser Leakage

Leakage of circulating water from the box to the steam space of the condenser does no harm if the circulating water is of the same quality as that used for the boiler feed makeup; however, leakage of impure circulating water into the condensate is equivalent to replacing that much of the boiler feed water with this inferior source.

If the circulating water is sea water or contains much chlorides, condenser leakage may easily be detected by a chemical analysis of the condensate. The method of making the silver nitrate test for chlorides is described in any standard work on quantitative analysis.

Leakage can often be quickly determined by measuring the electrical conductivity of the condensate, this being greater, the greater the quantity of dissolved solids. The conductivity meter may be calibrated by taking a given weight of distilled water and adding varying amounts of the circulating water. A curve of the resistance plotted against per cent of leakage can then be drawn up.

A method of detecting leakage which can be used when the chemical or electrolytic methods are not available is to shut down the steam side of the condenser and measure the quantity of water removed by the condensate pump. Split tubes can usually be noticed by the increase in the quantity of water in the hot-well. To determine the exact location of the leak, the condenser is shut down, the water boxes opened, and the steam space filled with water. If the condenser is suspended from the turbine exhaust flange and supported on springs, it is, of course, necessary to block the condenser up before filling with water, in order that the weight of the water may not strain the turbine exhaust. The leaks can easily be seen, and their cause determined. Water running from the tube indicates a perforated tube, while leakage around the end shows defective packing. Another method of detecting leakage which is somewhat quicker, but not so accurate, is to drain the water boxes of the condenser, draw a partial vacuum with the air pump and inspect the tube head with a candle, leaks being found wherever the flame is drawn in.

Split tubes, or tubes which leak badly from other causes, are usually plugged with wood or lead plugs until the number is sufficient to warrant a lengthy shut down for repairs. When replacing the tubes in the bottom of the condenser, or from any region in which the tubes are spaced on wide centers, a piece of quarter-inch pipe should be run through the tube before it is withdrawn, in order to guide the new tube through the holes of the support plate.

Several different types of packing are used on surface condensers. Wheeler condensers are usually supplied with corset lacing packing made by impregnating corset lacing with a measured quantity of paraffin. Such packing, carefully made with the correct amount of paraffin, and intelligently applied, care being taken not to screw the ferrules too tight and crush the tube, is extremely satisfactory. Another form of packing used in some cases is fiber rings which are easily applied, but perhaps more difficult to keep water tight.

If it is necessary to shut down the unit for a considerable period of time, the steam side of the condenser should be filled with water to save the packing as the throttle valve on the prime mover may leak. The condenser should also

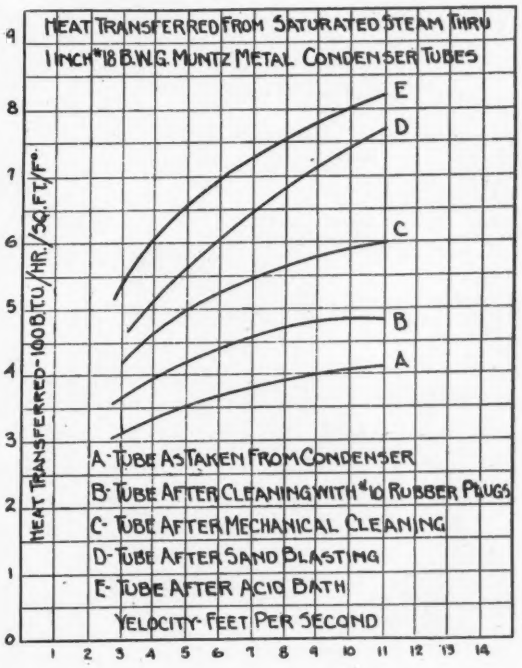

HEAT TRANSFERRED FROM SATURATED STEAM THRU
1 INCH #18 B.W.G. MUNTZ METAL CONDENSER TUBES
HEAT TRANSFERRED-1000 B.T.U./HR./SQ.FT./F°.
E
D
C
B
A
A-TUBE AS TAKEN FROM CONDENSER
B-TUBE AFTER CLEANING WITH #10 RUBBER PLUGS
C-TUBE AFTER MECHANICAL CLEANING
D-TUBE AFTER SAND BLASTING
E-TUBE AFTER ACID BATH
VELOCITY-FEET PER SECOND
0 1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9 10 11 12 13 14

FIG. 5. CURVES SHOWING THE IMPROVEMENT IN HEAT TRANSFER DUE TO CLEANING A CONDENSER TUBE BY DIFFERENT MEANS

be filled with water if the prime mover is run non-condensing. It is essential that the water be pure, as small particles of breeze and coal deposited on the walls of the tube cause corrosion which is accelerated by the fact that the water is not in motion.

The Texas Power & Light Co., Dallas, operating the Sweetwater Ice & Cold Storage Co., and the West Texas Electric Co., both of Sweetwater, has plans in progress for extensions and improvements in the two properties. A new addition will be constructed at the plant of the first noted company for ice-manufacturing and cold storage service. The power station of the West Texas Co., furnishing service to the ice plant, will be enlarged and additional equipment installed; a new transmission line will be constructed for a distance of about 40 mi., connecting with Snyder, Hermleigh and vicinity, where commercial service will be furnished. J. W. Carpenter is vice-president and general manager of the parent organization.

Diesel Engines Are Suited for Driving Ice Plants

FOUND DEPENDABLE, FLEXIBLE AND OF LOW POWER COST. BY A. EUGENE MICHEL*

ARTIFICIAL ICE making and refrigeration on a commercial basis demand some definite essentials in the power used. Chief among these are the following:

Dependability and continuity for long periods, especially while the high daily tonnage of the rush season must be produced.

Flexibility to the annual tonnage requirement and to the daily demand at seasons of widely different climatic conditions.

Cost per ton of ice made that will leave a good profit margin and protect profits in a field served by competing plants.

Freedom from smoke and noise nuisances outside the plant and heat liberation within.

Care-free utilization with moderately skilled operatives and reasonable labor costs.

Electric motor-driven apparatus, with the possible exception of the main ammonia compressors, is particularly desirable in ice plants because it operates at suitable speeds, goes into small space, has a low rate of depreciation, can be operated at low maintenance cost by men of average intelligence and altogether is much more economical than combinations of line and countershaft drives. At a recent convention of refrigerating engineers, an average power requirement of 45 kw-hr. all year around per ton of ice made, and running as high as 50 kw-hr. in sections where the water supply is warm, was conceded as fair for motor-driven plants.

In the vast majority of raw-water ice plants, the Diesel-electric type of power plant, including direct-connected or belted generators and main compressors has an advantage in meeting the previously mentioned combination of requirements.

TWO 400-HP. MCINTOSH & SEYMOUR DIESEL ENGINES DIRECT-CONNECTED TO 280-KW. ALTERNATORS, IN THE CARUTHERSVILLE, MO., ICE AND LIGHTING PLANT OF THE ARKANSAS & MISSOURI POWER CO.

Diesel power also affords an excellent means of rejuvenating an obsolete or inefficient steam-operated plant. The Caruthersville, Mo., installation shown in the cut is a typical example. When a fire destroyed the old steam plant, the management took the opportunity to convert the ice-making department to the raw-water system, and to change to oil engine power, for which the two 400-hp. Diesel engines and direct-connected 280-kw. alternators were installed.

By removing the steam ends of the ice machines and substituting electric motors with short drives, and increasing the speed, the ice production was increased from 28 to 45 t. per day without increasing the size of the tank, which holds 490 300-lb. cans. So good a tonnage is un-

*McIntosh & Seymour Corp'n, Auburn, N. Y.

usual for a tank of this size, but in this plant the force is able to freeze clear ice without cracking with 6-deg. brine, allowing only 11 cans per ton, although 16 cans per ton is the usual recommendation.

Operation of the power outfits on continuous 24-hr. schedule, with shut-down every other Sunday for inspection, has shown generating costs of less than 1 cent per kw-hr. in contrast with over 6 cents from the old steam plant.

Some of the waste heat in the exhaust gases and the jacket water of the engines is recovered by passing the water from the returns sump through the jackets, through coils in the engine exhaust muffler, and into the mains of hot-water heating systems of near-by houses. This scheme has been found to work out very well.

Large Ice Capacity and Little Storage vs. Low Capacity and Large Storage

Where heavy daily demand exists during four or more months of the year, sufficient power and machine capacity for maximum or almost maximum daily output will be found more economical than producing at a lower rate and storing most of the year to meet the peak during a few months. A large part at least of the saving in initial apparatus investment in the latter procedure is swallowed up by additional investment for storage space, by expense for maintaining storage temperature, by rehandling costs, loss from breakage in storing and rehandling, and by the impaired salability of the ice, due to less presentable appearance by the time of delivery.

Diesel power is adapted to overcoming these objections in the right way. Enough can be installed to meet the peak needs, without involving operating expense against the idle units during dull season. If all power is derived from a single main unit, that unit can be operated at light load during slack periods without greatly increasing the per-ton cost of ice produced, due to the fact that the fuel rate of a Diesel engine per horsepower-hour is almost as good at light as at heavy loads. At the same time, patrons will be better satisfied with the clean first-quality fresh ice, with its nicely squared edges, as so produced.

In comparing the two methods of operating, in a paper delivered before the 15th Annual Convention of the National Association of Practical Refrigerating Engineers, a prominent authority cited two typical plants, each for an annual production of 25,000 t. One plant was designed for 200 t. per day machine capacity and the other for 125 t. daily production with a 10,000-t. storage room. The initial cost of the latter plant was only 7.7 per cent less than that of the big-daily-output plant, but the annual expense including depreciation and interest was 8.05 per cent more, making a net saving of 23 cents on every ton produced, in favor of the plant with large machine capacity.

Diesel-electric Operation vs. Purchased Current

The question of generating its own or purchasing outside current arises sooner or later in almost every artificial ice plant. Cost of power from a self-contained independent Diesel-electric plant is within well defined guarantees of the apparatus builders, and is practically as low per kilowatt hour for a small as for a large plant, where with outside power, the current rate to a small plant is considerably higher. The power cost rate for a Diesel-electric plant is fixed permanently as far as engine efficiency is concerned, and can vary only with the rise and fall in the cost of fuel oil. The latter is too small an item to make much difference in the over-all costs.

The Lakeland and Jacksonville, Fla., plants of the Federal Ice and Refrigerating Co. afford good examples of the economy of Diesel power. The former plant, producing 300 t. a day, was equipped in 1920 with two 500-b.hp. Diesel engines and later an additional 150-b.hp. unit was installed. The Jacksonville plant started with purchased current, obtained at the unusually favorable rate of 2 cents a kw-hr., down to 1½ cents for consumption in excess of 75,000 kw-hr. a month. Having before them the costs of the Diesel-driven Lakeland plant, the owners, after 2 yr. operation, decided against further purchase of current at Jacksonville and installed two 400-hp. Diesel engines, each connected to a 312-kv.a. electric generator. Since the conversion, the Jacksonville plant has produced upward of 210 t. per day for weeks at a time.

Efficient, attractive and clean, without unsightly coal and ash pits or heaps, without soot and coal or ash dust in the air and on the walls, the Diesel plant makes for good sanitary conditions, first quality of ice and production cost per ton of ice so low that competitors will give it a wide berth.

Being smokeless, clean and quiet, a Diesel plant does not create opposition from the neighbors in populous districts, hence may be located at a central point, from which delivery costs are lowest. The importance of this advantage is steadily increasing because of traffic congestion, higher wages for wagon men, and because of zoning laws against the installation of certain types of plants.

Initial Investment and Depreciation

Although costing more than an equivalent steam engine alone, a Diesel engine is self-contained and complete; as no accessories are needed except oil storage tanks and a transfer pump, the engine cost is practically the total apparatus cost.

The size of engine chosen need be large enough for only the immediate future, as economy of operation is independent of the size of the unit and another can be added when needed, the resulting multiple-unit operation not increasing appreciably the horsepower-hour cost of the power output.

Sustained high thermal and mechanical efficiencies of a good Diesel engine make its purchaser reasonably safe against further improvement that would depreciate his investment. As 98 per cent of the Diesel engines built in the United States since 1904 are still in service, the life of this type cannot yet be accurately estimated, but depreciation from service can be figured conservatively as no greater than that of the steam engine. Unlike the gas engine, the Diesel operates on constant pressure combustion and without explosive shocks. The cylinder conditions produce an indicator card very similar to that of a steam engine, except that the Diesel card has a higher vertical scale. The operation is as smooth as that of a steam unit, which means that the wear and tear should be no greater.

Low Fuel Rate Per Ton of Ice

For comparable sizes, a Diesel engine produces more useful power per B.t.u. input at all loads, than is obtainable from any other type of commercial heat engine.

Operating records show that the fuel oil consumption per ton of ice made is usually from 5 to 6 gal. and in large plants as low as 4 gal.

In plants of small machine capacity where little ice

is drawn in winter except on two or three days per week and the compressor must be kept in operation to hold the tank and storage temperatures, 7 gal. of fuel per ton of ice is a conservative yearly average. From the fuel to the bus bar, the efficiency of a Diesel-electric outfit in such a plant is upward of 30 per cent.

Reliability, Attendance and Maintenance

Given intelligent care, a Diesel engine will operate for weeks or months without a shut down and with undiminished capacity and economy. It can be started without preliminary warming, reaches capacity within 2 or 3 min. and is reliable for continuity of operation. A 665-hp. Diesel engine in the Needles, Calif., car icing plant of the Santa Fe Railroad, was operated 191 days continuously night and day on one run and was shut down at the end of this period only because there was no further immediate need for more ice. The only adjustment required at the end of this run before putting the engine back into service was the slight tightening of two main bearings. The piston rings were all free, and the exhaust valves, compressor valves and fuel needles needed no change.

In pipe-line pumping stations, where steady dependable service is of prime importance, Diesel engines are kept in operation as much as 99 per cent of the time and maintain this schedule for years without fatigue.

Engineers soon learn to like a Diesel plant because it relieves them of many duties and eliminates coal and ashes handling. Attendance is small, as the Diesel engine is a one-man unit at most and the man can usually operate two or three engines almost as easily as one, or utilize part of his time in other work.

Maintenance cost of a Diesel engine, like its fuel economy, is about the same per unit of power generated, regardless of the size of the plant.

Less expensive lubricating oil may be used. A gallon should last for at least 5000 hp-hr., although consumption depends entirely upon careful attendance.

Reliable operating records from typical Diesel plants with proper attendance indicate that the repair costs during a 10 to 12-year period are approximately 1½ per cent of the plant cost.

Fuel Handling and Storage

Fuel can be conveniently delivered from tank cars into a storage tank, thence handled into a small daily-service tank in the engine room by a small motor-driven pump. Old tanks from tank cars afford excellent storage and when properly overhauled are serviceable long after they are unfit for further railroad service.

Weight of fuel required is only about one-eighth to one-third of that for a steam plant. This makes savings in districts away from the railroad, where transportation is expensive and is an advantage in maintaining steady running during a fuel shortage.

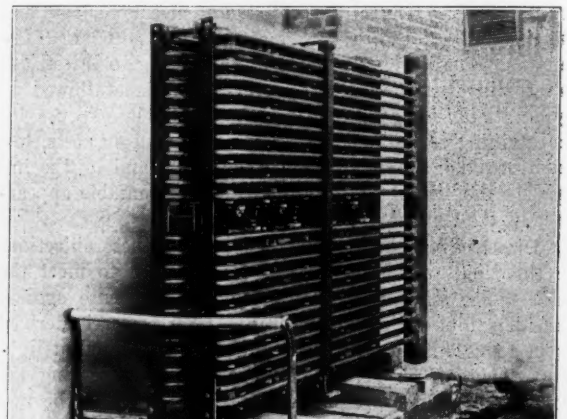
Accumulation of fuel to last over a long period is entirely practical, as it can be conveniently stored and will not deteriorate in the tanks; hence it can be bought during low cost periods.

Some plants carry the warm jacket water around a dip tank where the ice cans may be immersed for a minute or two to make the cakes slide out easily.

Although their temperature is high, the amount of heat in the exhaust gases is not large, since the volume of these gases is comparatively small. Yet much of the heat in the Diesel exhaust can be saved. Jacket water is sometimes drawn through coils in the engine exhaust where the water can be heated to 180 deg. and circulated through the mains of a hot water heating system in nearby buildings, the returns from such systems being suitable for re-circulation through the engine water jackets.

Electric Heaters Superheat Process Steam

TWO ELECTRIC steam superheaters are being used by the Vegetable Oil Company, West Berkeley, Calif., in order to supply suitable steam for one of its processes, dry steam at a temperature of 650 deg. F. being needed and the steam available having a temperature of only 300 deg. F. Each of these superheaters, which were designed by the company, has two banks of U-shaped steam pipes, with 16 General Electric air heaters within the U's, as shown in the illustration, the total connected load being 60.2 kw.

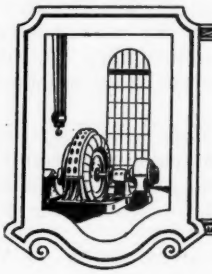


ELECTRIC AIR HEATERS, PLACED INSIDE U-SHAPED PIPE COILS, GIVE 350 DEG. SUPERHEAT, WITH CAPACITY OF 500 LB. PER HR.

Dry steam enters the apparatus at 300 deg. F., the temperature corresponding to the pressure, and is superheated to 650 deg. F., or a superheat of 350 deg. F., the capacity being approximately 500 lb. per hr.

The superheater is enclosed in a furnace, unventilated, with sheet metal lining inside and outside, and nine inches of insulating brick between. There are no doors or openings. There are four electric circuits, each one independently controlled by hand; an indicating thermometer shows the steam superheat. The control is arranged to light a pilot light whenever units are energized, thus acting as a safeguard against leaving units unattended with power on, with the possibility of burning out units from overheating.

Electricity was chosen for superheating in preference to a combustion method because of the improved fire and insurance risks which resulted. It was necessary to superheat the steam at a point near the center of the factory for vegetable oil chemical process. One superheater has been in use for a number of months and a second has recently been built.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Principles of Transformer Connections

PART III. THREE PHASE TRANSFORMATION WITH TWO SINGLE PHASE UNITS. USE OF THREE PHASE UNITS. TERTIARY WINDINGS. BY V. E. JOHNSON

CONTINUING OUR discussion of polyphase transformation started in Part II of this article,* we will now take up the method of effecting three phase transformation by the use of two single-phase units.

Three-phase transformation may be accomplished by using two units connected in "open delta" or "V" as shown in Fig. 1, or in "T" as shown in Fig. 2. Of these two, the former is more common because of the fact that it requires no special taps or coil arrangement. The T connection can not be made unless one of the units has a 50 per cent tap or middle point available.

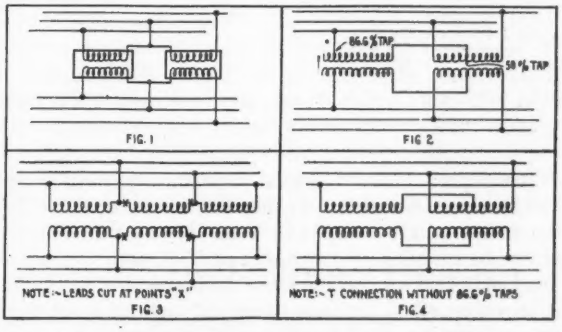
It is the possibility of open delta operation in a straight delta-delta installation, that makes this connection desirable for if one of the units fails, it may be cut out of service and three-phase power obtained from the two that remain. For example, if one of the transformers in the closed delta shown in Fig. 3 burns out, service can be continued by merely cutting off the leads at the points indicated by the crosses. There would be a reduction of capacity, but at any rate some power would be available.

As in Fig. 2, the T connected bank consists of two units designated as the "main" and the "teaser". The latter is connected to the middle point of the "main" and should, theoretically, have its other terminal brought to the line through an 86.6 per cent tap. It is usual, however, to omit this tap and to connect the full winding to the line, as per Fig. 4. There would be some distortion of voltage, but not enough to make any practical difference under ordinary conditions. Nevertheless, even with the omission of the 86.6 per cent tap, somewhat special units are required to provide the middle point on both the primary and secondary and this necessarily restricts the use of this scheme. It could be used to maintain service if one unit in a delta failed, but the V connection is simpler and preferable.

COMBINED RATING OF TWO TRANSFORMERS CONNECTED IN "V" OR "T"

The kilovolt-ampere output of a piece of three-phase apparatus, or passing through a three-phase circuit, is expressed by the formula: kv.a. equals $\frac{E \times I \times 1.73}{1000}$ where E equals the voltage from phase to phase, and I the current in the mains. If the voltage of a transformer be designated as V, and the current rating as C, a single phase unit has a kilovolt-ampere capacity of $V \times C \div 1000$ and a three unit bank a capacity of $3 \times V \times C \div 1000$, as was demonstrated in a previous article. With a closed delta connection the line current I will equal $1.73 \times C$ at full rated load.

With an open delta connection each of the two units must carry the entire line current, so that with the same



FIGS. 1-4. METHODS OF EFFECTING THREE-PHASE TRANSFORMATION WITH TWO SINGLE PHASE UNITS

size transformers, the current output will drop from I equals $1.73 \times C$ to I equals C. Substituting V and C for E and I in the fundamental formula the output of the open delta setting becomes: kv.a. equals $V \times C \times 1.73 \div 1000$.

Compared to the rating of the three unit bank, it is seen that the capacity has been reduced in the ratio of 1.73 to 3 or $\frac{1.73}{3}$ equals 58 per cent. In other words, two transformers have only 58 per cent of the capacity of three transformers.

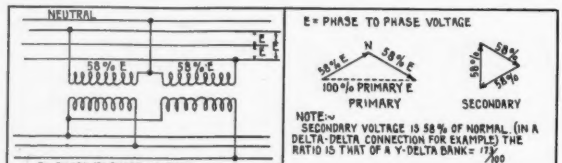
Example: A closed delta bank consisting of three 100 kv.a. units has a total capacity of 300 kv.a. If one of the units is disconnected, the remaining two in open delta will have a capacity of 58 per cent of 300 kv.a. or 174 kv.a.

If the previous output of I equals $1.73 \times C$ is to be maintained, it will be necessary to supply transformers in the open delta scheme, large enough to permit the entire current to pass through each unit. Each must therefore have a rating of $V \times 1.73$ C, so that to supply the 300 kv.a. in the example will require two 173-kv.a. units, or 15 per cent more capacity than needed in the three transformer setting.

Applying the same reasoning to a T-T bank, it will be seen that the main transformer has to carry full line current and has full line voltage across its terminals. Therefore, if the line current is to be equal to that of a

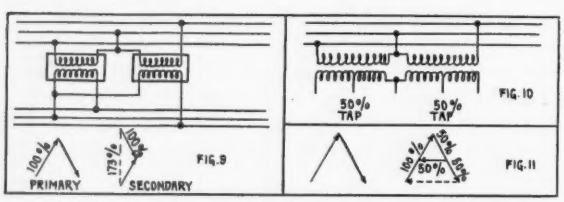
*November 1, Issue, page 1102.

closed delta bank, namely 1.73 × C, it is necessary to have the main transformer of the T rated to carry it. Its capacity will accordingly be 1.73 × V × C. The teaser transformer must also carry full line current and will also have to be rated at 1.73 × C amp. if the closed delta rating is to be maintained. Its voltage need be only 86.6 per cent E, but, as a matter of fact, the two units are actually identical in practice. Therefore the combined ratings of the T-T must be 2 × 1.73, or 3.46 times the capacity of one of the closed delta units.



FIGS. 5-8. CONNECTION DIAGRAM OF 3-PHASE, 4-WIRE SYSTEMS WITH CORRESPONDING VECTOR RELATIONS SHOWN

Example: Three 100-kv.a. transformers will supply 300 kv.a. in closed delta. If they are re-connected for T-T, the rating will be only 1.73 kv.a. If the full 300 kv.a. are to be supplied by two units in T-T, each one will be rated at 1.73 kv.a., or a total of 346 kv.a. for both. This is an excess of 15 per cent in capacity as compared to the original setting.



FIGS. 9-11. MORE THREE-PHASE, TWO-TRANSFORMER SYSTEMS WITH VECTOR DIAGRAMS

It will thus be seen that as far as capacity is concerned, it is immaterial whether an open delta or a T connection is used; however, if a full winding is used for the teaser, it will operate at a lower flux density, therefore having somewhat lower losses, so that the T-T arrangement is somewhat more efficient than the delta-delta.

In the open delta connection there is at unity line power factor a 30 deg. phase displacement between the current and voltage, the current leading by that amount in one winding and lagging an equal amount in the other. This results in unequal regulation and unbalanced voltages at low power factors.

Open Y Connection

Figure 5 shows a connection used on three-phase, four-wire systems but which is not as common as the open delta arrangement. It will be noted that this can not be used unless the neutral is available. To obtain balanced voltages on the secondary side, it is necessary to reverse one of the units, thus producing the voltage diagram in Fig. 6. This scheme is sometimes referred to as "Star-reversed open star" or Y-reversed open Y." If the reversal were not made as indicated, but the connection made straight (see Fig. 7) the voltage would be unsymmetrical as shown in Fig. 8.

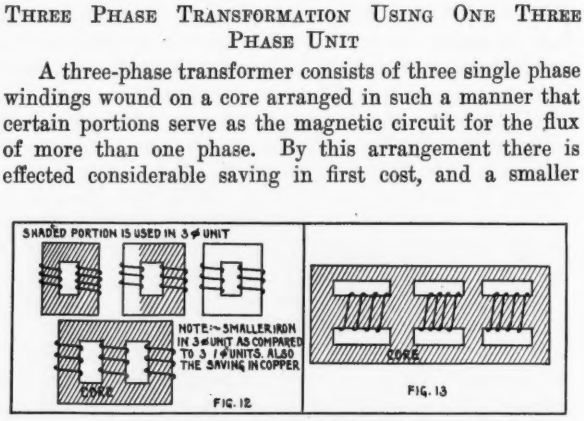
It is interesting to note that a voltage diagram such as that in Fig. 8 can be obtained from the open delta or V connection shown in Fig. 1 by reversing one of the units. The connection and voltage diagrams are shown in Fig. 9.

Double Voltage Secondaries in Open Delta or V Connections

On transformers having two coil secondaries, a connection as shown in Fig. 10 may be used to supply three-phase loads at different voltages. A typical set of values is indicated on the diagram in Fig. 11.

Three Phase Transformation Using One Three Phase Unit

A three-phase transformer consists of three single phase windings wound on a core arranged in such a manner that certain portions serve as the magnetic circuit for the flux of more than one phase. By this arrangement there is effected considerable saving in first cost, and a smaller


SHADED PORTION IS USED IN 3 ϕ UNIT
NOTE:—SMALLER IRON IN 3 ϕ UNIT AS COMPARED TO 3 1 ϕ UNITS. ALSO THE SAVING IN COPPER
CORE
FIG. 12
CORE
FIG. 13

FIGS. 12-13. SKETCHES SHOWING RELATIVE QUANTITY OF IRON IN THREE-PHASE TRANSFORMERS OR ONE THREE-PHASE TRANSFORMER

space required for installation. Figure 12 shows the relation between three single-phase and a three-phase unit. The shaded portion indicates the points at which a saving in material has been made. The type indicated is known as "core type." The "shell type" is shown in Fig. 13.

The choice between three units and one unit for three-phase transformation is based on several considerations. If the total installation consists of one three-phase transformer, there is a lack of flexibility, for it would be under most circumstances impossible to operate in an emergency with one of the windings cut out, as would be the case for a delta-delta three-unit bank. In order to have a spare, it would be necessary to provide 100 per cent extra capacity. For single-phase units, it would be necessary to have only 33 1/3 per cent extra capacity. Example: For a 1000-kv.a. installation, either one 1000-kv.a. three-phase unit, or three 333-kv.a. units would be required; however, to provide for emergency operation, one three-phase, 1000-kv.a. transformer would be required in the first instance while in the second one 333-kv.a., single-phase unit would suffice. The price comparison would therefore have to be based on two 1000-kv.a. as against four 333-kv.a. units.

If the total installation is large, so that the failure of one unit would represent but a small portion of the entire capacity, this matter of spare units would not be of much importance and in that case cost, space and ease of handling would be the deciding factors.

Inasmuch as the windings of a three phase unit are independent they may be connected in the same way as

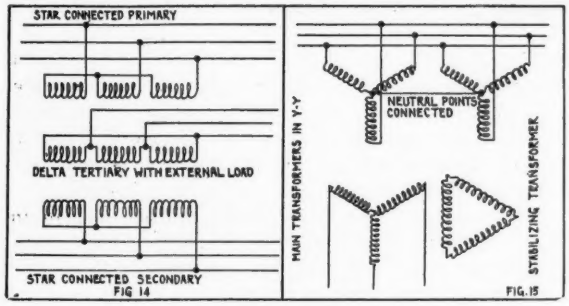


FIG. 14-15. TERTIARY CONNECTIONS

single-phase transformers, namely: star-star, delta-delta, star-delta and under certain conditions, open delta. The same rules as to polarity and phase rotation apply, and the fundamental underlying principles may be applied to both cases in an analogous manner. These points will be analyzed in a succeeding article.

A star-star unit will not operate satisfactorily unless some means be provided to keep the neutral from shifting. This is particularly true when attempts are made to take off unbalanced single phase loads from line to neutral. Under certain conditions, core type units may be operated under the foregoing conditions with fair results, but in general it is best to approach such schemes with caution.

Star-star units or banks will also have distorted wave shapes appearing in their voltages, due to the presence of a third harmonic component. These cause abnormal voltage stresses which may cause breakdown.

In order for a star-star transformation to be satisfactorily operative, it has been found necessary to employ one of several remedies. A common method of obviating the trouble is mentioned under "Three-Phase, Four-Wire Systems" and consists of joining the primary neutral to the generator neutral. This fixes its location definitely and eliminates the third harmonic component.

A second, and less common, arrangement which may also be applied either to three-phase units or to three phase banks, consists of equipping the transformers with tertiary windings connected in delta. Each phase will then consist of three windings on a common magnetic circuit, these windings being designated as "primary," "secondary" and "tertiary." The primary and secondary would be used for the transmission of power, and would be star-star connected, while the tertiary winding would be connected in closed delta, thus functioning as a stabilizing winding, keeping the neutral from shifting and eliminating the third harmonic voltage.

This tertiary winding may be designed to carry only the magnetizing currents, but it must be able to withstand the stresses imposed upon it by abnormal operating conditions. In addition to serving as a stablizing winding, it may also be used to supply external loads, but in that case the coils must be proportioned accordingly.

Figure 14 shows a tertiary winding with leads brought out to supply an external load at a third voltage. In operating such a unit, care must be taken that the entire load on the three sets of coils does not exceed the rating of the unit, and also that the load on any one winding does not exceed its capacity.

Figure 15 shows a third method of stabilizing the neutral and consists of a star-delta bank connected to the star-star bank in the manner shown. It should be noted that the two secondaries can not be paralleled as there is a 30 deg. phase displacement between them. The delta serves as a stabilizer, holding the neutral in place, and also preventing trouble from the third harmonic voltage component.

Three Phase Units with One Phase Damaged

Theoretically it is possible to operate a three phase transformer with one winding damaged. In shell type units, the faulty winding is disconnected from the other two and short circuited upon itself. In core type units, it is disconnected and left open circuited. Under these conditions it will have normal voltage generated in it, therefore it must be able to stand this without breaking down.

In actual operation, the preceding rules can seldom be applied, for a failure in one phase usually affects the other two. Due to the fact that all three are confined in the same tank, damage will in most cases extend to some extent to the whole coil structure. The terminal board will possibly be destroyed, and the oil contaminated, necessitating the removal of the core and coils from the tank. It would be, to say the least, somewhat hazardous to put a unit back into service after having merely cut out the damaged phase. Certainly this should not be done without determining the extent of the injury and testing the oil.

The capacity of a three-phase unit in open delta is covered by the same rules as apply to single-phase units under similar conditions. There might be some deviation in allowable load, due to the fact that 100 per cent radiating tank surface would be available in the former, even though one of the circuits was out.

Hawaiian Turbine Has Remarkable Service Run

OUT OF SERVICE only 29 hr. in 52,000 hr. of operation is the remarkable service record of a steam turbine unit installed in the station of the Hawaiian Electric Co., Honolulu, T. H. This is one of the best records ever established by a turbine unit.

This turbine unit, which is rated at 2000 kw. was installed in July, 1914, and was in continuous operation from that time until June, 1920, during which time it

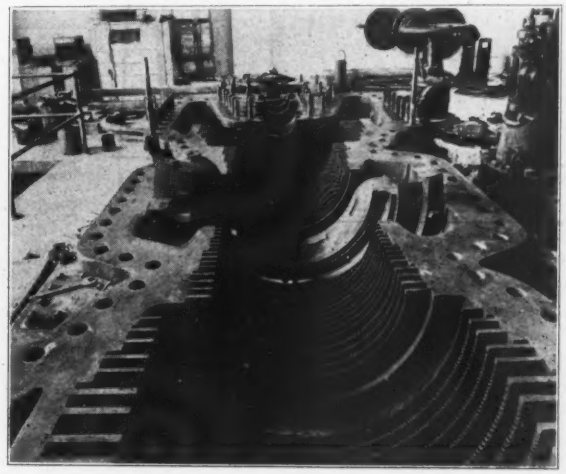


FIG. 1. STATOR OF HAWAIIAN TURBINE, SHOWING EXCELLENT CONDITION OF BLADING AFTER HAVING RUN 52,000 HOURS

was out of service only 29 hr. This outage was not caused by turbine trouble but was due to the necessity of cleaning the condenser or repairs to condenser auxiliaries.

The turbine is of the Parsons reaction type and was built by the Westinghouse Electric and Manufacturing Co. During its lifetime nothing has been spent on blading repairs. Recently in moving this turbine into a new station,

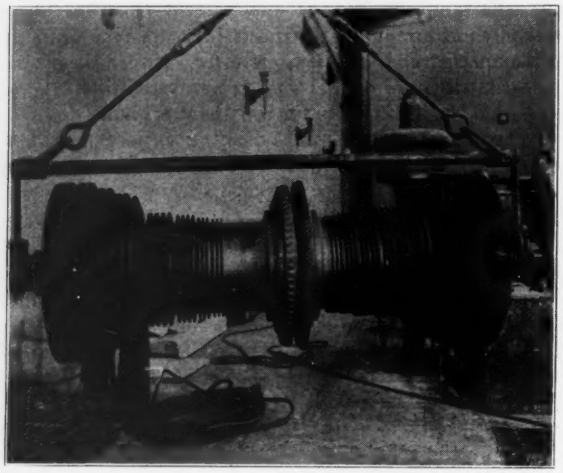


FIG. 2. ROTOR OF TURBINE, REMOVED FROM MACHINE WHEN MOVING TURBINE INTO NEW STATION

it was thoroughly inspected and the blading was found to be in excellent condition. It is also interesting to note that the oiling system for this unit was never cleaned during this long period of operation.

Protecting the Fireman's Eyes

By W. J. Risley, Jr.

NOBODY gave any particular thought ten years ago, to the injuries that might result to the eyes from exposure to sources of intense light or to invisible light rays. Now the subject is beginning to receive some intelligent attention.

At the time of the eclipse of the sun last winter, warnings given by scientists that the eclipse should be viewed through darkened glasses, were given wide publicity. Even at that, thousands of people watched the phenomenon without the use of glasses at all and many suffered serious injury to the eyes. Some were even blinded. Certainly a striking example of the powerful effects of intense light rays.

When arc welding of street car rails began to come into general use, it was found that it was not sufficient to protect the eyes of the welder alone. Curiosity would impel almost anybody passing by to stop and watch the mysterious process of rail repairing and it was necessary to surround the work with a shield that would discourage passerby from looking at the arc.

The Bureau of Mines reported the results of an official observation some years ago of an arc welding test on a street railway. The observing group consisted of a number of engineers and utility executives who contemplated the adoption of this method of rail repairing. The test lasted about an hour, during which time all of the observers watched the work more or less closely. Three or four of these men wore amber glasses to lessen the glare. The rest used no protection.

The effects of the rays from the intense source of light were very serious. The men who had worn the amber glasses were only slightly affected. All the rest suffered intensely from the eyestrain. Most of them were weeks recovering. Some spent over a week in darkened rooms, with ice-packs on their eyes.

Of course, there are no such severe conditions in the boiler room. Few people realize, however, the possible danger that often exists in the observation of a boiler furnace fire. The hotter the fire, the more intense the light rays emitted. With hand-fired, natural-draft furnaces in small industrial plants where the boilers are seldom pushed beyond 75 or 100 per cent of their rating, furnace temperatures are not high and the light rays are not particularly harmful.

In stoker-fired, forced-draft plants, furnace temperatures are much higher, and operation at 300 to 400 per cent of rating may bring fuel bed temperatures as high as 2800 to 3000 deg. F. The light from such fuel beds is extremely intense, as any fireman will attest whose duty it is to inspect and clean such fires.

There are several sources of danger from such light. Everybody is familiar with the method of using a prism to separate the various colors that blend to make white light—the violet, which are the light rays of short wave-length at one end; on through the blue, green, yellow and orange; and then the red, which are the rays of greater wave-length, at the other end. Beyond each end of this visible spectrum lie the invisible rays that are injurious to the eye. Next to the violet come the shorter length ultra-violet rays; and at the opposite end come the infra-red, or heat rays, which have a much greater wave-length than the visible red rays.

Ultra-violet light rays are capable of penetrating clear through the eye, and are very injurious, sometimes causing severe cases of what the doctors call "conjunctivitis" (an inflammation of the membrane that covers the eyelids and part of the eyeball). This would result from long exposure to electric arc rays, which are rich in ultra-violet light. The rail test observers mentioned above suffered from this. Whether or not a furnace fire produces enough such rays to injure the eye is still a question.

It is certain, however, that the infra-red, or heat rays, given off from a boiler furnace fire, do have a destructive effect on the eyesight because of their tendency to produce "burns." This is purely a thermal action and its effect is felt whenever we open the furnace door to inspect the fire.

Another source of severe injury to the eye is the glare. The hotter the fire in the furnace, the more nearly white the fuel bed appears to be. If we attempt to watch the fire for any length of time, nature tries to cut down the amount of intense light entering the eye by contracting the pupil. This contraction, if continued, strains the muscles of the eyes abnormally and produces sharp pain and possibly headache. All of these ill effects, whether from the intense light or from heat rays, are cumulative in their action.

The natural tendency of the fireman is to cut as short as possible the operations of inspecting the fires, cleaning side-walls, or dislodging clinkers. He may not realize this tendency to slight his work, or the cause of it; nevertheless, it exists.

In plants where furnace temperatures are high, each

fireman should be provided with his own pair of comfortable, light, well-ventilated goggles, to be worn whenever he works on the fires. He should be told why he should wear them, and the wearing should be insisted on. In addition to goggles, there should be hung beside each inspection door a convenient wooden frame holding a plate of the proper glass, to be used by anyone looking at the fires. The results will be beneficial both to the management and to the workers.

Consideration of the dangers to be guarded against will make it apparent that the ideal glass would be one which shuts out (absorbs) completely the ultra-violet and the heat rays, and would transmit only enough of the visible rays to prevent irritation and injury to the eye. In other words, it should absorb the dangerous invisible rays and eliminate glare.

The Bureau of Standards has tested scores of typical samples of glasses, including many widely advertised commercial protective glasses, and has found that by far the best protection is afforded by such glasses as "Signal Green," "Ferrous Sage-Green," and a similar glass known as "Noviweld."

Such glasses, used in goggles and in wooden frames, offer complete protection to the eyes and will constitute a profitable investment for the boiler plant owner.

New Equipment Contributes to Fuel Saving

CHANGES IN BOILERS AND STOKERS INCREASE CAPACITY AND EFFICIENCY. BY CHARLES J. HERBECK*

UP TO this year the boiler equipment at the Cedar Rapids Station of the Iowa Railway and Light Co., consisted of eight 625-hp. Edge Moor boilers equipped with No. AA-6 Taylor stokers having 15 tuyeres and 7 retorts; and four 500-hp. and two 598-hp. Edge Moor boilers equipped with chain grate stokers.

This year we changed over two of the 625-hp. boilers and increased the steaming capacity of the two enough to eliminate the need of an additional 625-hp. boiler.

DOUBLED CAPACITY OF BOILERS

To accomplish this the settings were raised and additional tubes were added to each boiler, increasing its rating 100-hp., making the boilers now 19 tubes high and 20 tubes wide, whereas before they were 16 tubes high and 20 tubes wide. The boilers were turned end for end so that the tubes slope toward the front of the boilers. The old stokers were replaced by type HC-6 Taylor stokers having 29 tuyeres and 7 retorts.

These two boilers were put in operation in September, 1924, and while only 100 hp. of tubes were added to each boiler, the new settings with the deeper stokers have enabled us to double the steaming capacity of the boilers. Whereas, formerly we ordinarily developed about 800 hp. with the 625-hp. boilers, we now carry 1250-hp. on them. Previously, the maximum load that could be developed was about 1100 hp. per boiler, but now we can get 1900 hp. out of each one. They can operate at 1800 hp. for unlimited periods. It is interesting to note that the flue gas temperature is now 550 at 1300 hp., which is no higher than it formerly was at 900 hp.

These boilers are quick steamers and are able to meet changes in demand promptly. We can increase the load on one boiler from 1200 hp. to 1900 hp. in two minutes.

In the accompanying tabulation is shown the steam generated and the coal burned by both boilers in November, 1923, before changing and in November, 1924, after the changes were made. The efficiency of the two boilers is now 74.09 per cent, whereas it was 64.32 per cent a year ago. The 9.77 per cent increase in efficiency means that the boilers now consume 13.19 per cent less coal per pound of steam than before the changes were made. We feel that this is justification in itself for the changes.

SAVING IN INVESTMENT AND LABOR

In addition to the improvement in operating efficiency, we have saved the investment in a 625-hp. boiler with its stoker and setting which would have cost much more than the new stokers, settings and changes. We are also saving the maintenance and repair costs on the extra boilers.

In our boiler room the boilers are set four on each side of the aisles. The 16 boilers take up all the space available in the boiler room. If we had put in an extra boiler, we would have been compelled to construct an addition to the building and a new stack. As the boiler would not have been on either of the present two aisles, it would have been necessary to add another fireman to each shift.

COMPARISON OF NO. 1 AND NO. 2 BOILERS SHOWING SAVING DUE TO CHANGES MADE IN BOILERS AND STOKERS

(Figures show total of both boilers)

	Nov., 1923	Nov., 1924
Steam generated	15,886,822 lb.	37,273,199 lb.
Coal burned	2,402,650 lb.	5,293,905 lb.
Evaporation	6.612 lb.	7.041 lb.
B.f.w. temperature	200 deg.	196 deg.
B.t.u. as fired	11,222	10,461
Superheat	100 deg.	110 deg.
Efficiency	64.32 per cent	74.09 per cent

Increased efficiency in 1924 over 1923 = 74.09 — 64.32 ..... 9.77 per cent

The fuel saved in 1924 over 1923 = $\frac{74.09 - 64.32}{74.09}$ ..... 13.19 per cent

Besides effecting these economies, we have the further advantage of equipment which is more flexible and better able to meet the load conditions.

Radiator Paint Cuts Down Efficiency

TO GET THE highest efficiency out of your heating system, don't paint your radiators with the conventional aluminum or gold bronze. The kind of paint used has a marked effect upon the radiation constant but has no material effect upon the heat lost by convection. As shown by the following table, white paint gives the highest efficiency. The number or quality of the primary coats has little effect on transmission, which depends entirely on the last coat.

Condition of Surface	B.t.u. per sq. ft. per hr.
Cast iron, bare	240
Painted with aluminum bronze	200
Painted with gold bronze	205
Painted with white enamel	242
Painted with maroon japan	240
Painted with flat green enamel	230

*Chief Engineer, Cedar Rapids Station, Iowa Railway and Light Co.

Power Saving Due to Lowering Condenser Pressure

By Charles H. Herter

SOME TIME AGO the question arose at a plant with which the writer is connected as to how much power would be saved by reducing the head pressure on the refrigerating system from 210 or 215 lb. gage to about 175 or 180 lb. The manner in which we determined this may be of interest to other readers of this magazine. The plant contained two compressors, one a 9 by 9-in. unit driven by a 50-hp. motor and the other an 8 by 8-in. compressor driven by a 40-hp. motor.

When the data on this installation was given to me the suction pressure was not specified, neither was the speed of the compressors or indicator cards, so certain assumptions had to be made.

In every case of this kind the horsepower required is proportional to the mean effective pressure within the cylinder. If clearance volume is neglected, the theoretical mean effective pressure with adiabatic compression is obtained quite accurately for ammonia by the following formula:

$$\text{Theo. m.e.p.} = 4.333 \left[\left(\frac{P_2}{P_1} \right)^{0.2308} - 1 \right] \times P_1 \ldots\ldots\ldots (1)$$

The value found by this formula is then corrected and reduced somewhat due to re-expansion of compressed gas in the clearance space. We, therefore, had to make some assumptions.

Assuming suction pressure, P_1, to be 20 lb. gage (35 lb. absolute) and the present condenser pressure, P_2, 210 lb. gage (225 lb. absolute), then the ratio of pressures $P_2/P_1 = 225/35 = 6.43$ to 1. After the condenser pressure is lowered to 175 lb. gage, the ratio of absolute pressures will be $190/35 = 5.43$. It is permissible to assume in these cases that the correction required by allowing for suction line depression and for high expulsion pressure is offset by the expansion of vapor in the clearance space.

The theoretical (and assumed actual) m.e.p. by formula (1) is then found to be:

For the present case, 83 lb. per sq. in.

For the future case, 74.4 lb., or fully 10 per cent less.

By means of the long established formula (2)

$$\text{hp.} = P\,L\,A\,N \div 33{,}000 \qquad (2)$$

the indicated compressor cylinder horsepower is found. In this, P stands for m.e.p., L = length of stroke in ft., A = the area of piston in sq. in., and N represents the number of compression strokes per min.

Assuming one double-acting 9 by 9-in. horizontal compressor at 200 r.p.m., piston rod 2¼ in. diam., then effect on piston area = 63.617 sq. in., less half the area of rod, 1.99, leaves net 61.63 sq. in.

I.Hp. $= 83 \times 9/12 \times 61.63 \times 200 \times 2 = 1{,}538{,}000 \div 33{,}000 = 46.6$ I.hp. To allow for friction, we divide by 0.90 and obtain 51.8 brake hp. At 0.746 kw., this would be 38.6 kw., but after allowing again 10 per cent loss, the current at switchboard is $38.6 \div 0.90 = 42.9$ kw. per hr. Multiplying this by 24 hr. running per day and 30 days per month, the total kw-hr., with the 9 by 9-in. compressor, with 210 lb. pressure, becomes $42.9 \times 24 \times 30 = 30{,}900$ kw-hr. per mo. When the condenser gage pressure has been reduced to 175 lb., the total kw-hr. per mo. will be about 10 per cent less, or $30{,}900 \times 0.90 = 27{,}800$. In a similar manner, the performance of your 8 by 8-in. compressor can be estimated.

Lowering the condenser pressure, either by using more condensing surface, more water, or colder water, or expelling all non-condensable gas, causes not only a saving in power but increases the refrigerating capacity of the compressors per revolution because of the greater useful refrigerating effect obtained with the cooler condensed liquid. Thus the latent heat of evaporation per lb. liquid ammonia at 20 lb. evaporator pressure is 565 B.t.u. less the difference in heat content at 210 lb. and 20 lb. or 159 — 48, or a loss of 111 B.t.u., leaving net 454 B.t.u. useful effect per lb., so that in this case 200/454 or 0.44 lb. liquid or $0.44 \times 8.15 = 3.59$ cu. ft. saturated vapor must be circulated per min. per ton of refrigeration.

After the condenser pressure has been reduced to 175 lb., the above mentioned loss, due to first having to cool the warm liquid from condenser temperature down to the evaporator temperature of 5 deg. F., is only 147 — 48, or 99, leaving net 565 — 99, or 466 B.t.u. available for work, so that in this case 200/466, or 0.429 lb. liquid, is required per minute per ton, which corresponds to $0.429 \times 8.15 = 3.5$ cu. ft. suction vapor, or a gain in capacity of 2.6 per cent, or in reality at least 3 per cent, because of the lower ratio of pressures.

As the real volumetric efficiency of the compressors at 200 r.p.m. is not in excess of 75 per cent, the displacement required per minute per ton of refrigeration at 20 and 175 lb. is about $3.5 \div 0.75 = 4.67$ cu. ft. or 8006 cu. in. With 25 lb. pressure, multiply by 0.86; with 15 lb. pressure, multiply by 1.16.

Full information on the thermal properties of anhydrous ammonia is given in Bulletin 142, Bureau of Standards, obtainable from Government Printing Office, Washington, D. C., for 10 or 15 cents.

Industrial Health Conservation Is Sound Business

By H. L. Williams

TUBERCULOSIS in industry is decreasing. During the past 20 yr. the death rate from this disease for the entire country has been reduced by one-half. A part of this gain at least, may fairly be attributed to the sunlight factories, exhaust fans, dust-protecting masks and other health measures, which have become commonplaces in industry. Physicians and health workers urge employers to install further protecting measures for working men and women, yet many employers are questioning whether the expense of such equipment is really justified as a sound business investment.

It requires careful consideration of the studies which industrial physicians and life insurance company statisticians have made of tuberculosis to understand the uses of what is known as "industrial medicine." The Metropolitan Life Insurance Co., for example, has found that more men than women die from tuberculosis after the age of 25. They infer from this that the higher death rate for men is due to industrial strain, as after the age of 25, women, for the most part, are employed in the more sheltered occupations of the home. To substantiate this, they point to the figures of the war when large numbers

of women entered the industrial field and the tuberculosis rate among them rose suddenly and stayed up until the wartime occupations were discontinued. This would seem to indicate that the wear and tear of daily industrial labor constitutes a strain on health.

Labor turn-over and loss of time through illness cause a considerable loss to most employers of labor. To prevent this loss, and experts maintain that it is preventable, large industrial plants have installed departments of preventive medicine for their workers, in which all sorts of diseases are diagnosed and treated, their greatest efforts, however, being sometimes centered on tuberculosis prevention. This is thoroughly logical, for wholesome food, fresh, air, exercise and sufficient rest, still the most reliable preventives as well as treatment for tuberculosis, also build up the physical resistance so that it can throw off almost any other kind of germ.

Experience proves that the physical appraisal of working men and women gives the employer a fair knowledge of the strength of his force. It also helps him to assist the weaker and to correct easily remedied defects. An example of the latter occurred in a rubber footwear factory where to the great annoyance of the manufacturer imperfect work was going out to the trade. When the eyesight of the inspecting force was checked up, it revealed the astonishing fact that 20 per cent of the group had such defective vision that they were useless in this particular work. After the proper corrective measures had been applied, the quality of that firm's product was quickly restored to its old level. A large shoe manufacturing company in the middlewest introduced a medical service into its plant of 2000 employes. Within one year 28 active cases of tuberculosis, including the works manager, had been discovered and removed for proper treatment.

According to Frank L. Rector, M. D., "The gains in improved morale and continuity of employment, to say nothing of the humanitarian questions involved, will make health improvement a profitable investment."

It is one of the aims of the National Tuberculosis Association and its affiliated organizations to educate working men and women to better understanding of the rules of healthful living, thereby making them not only happier but more useful as producers. In order to further this campaign of education, the eighteenth annual sale of Christmas seals will be held throughout the country in December.

Graphic Method of Extracting Roots

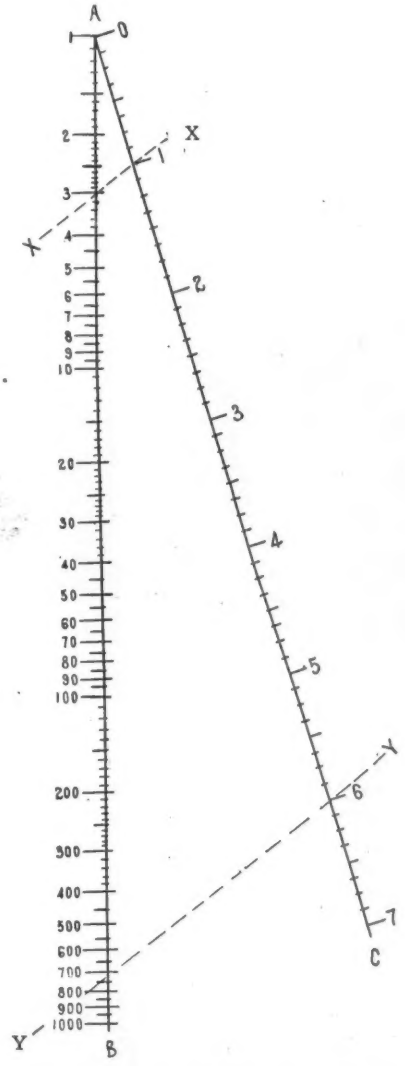
By W. F. Schaphorst

MANY complicated methods have been published showing how to extract the square root, cube root, fourth root, fifth root, etc., mathematically. Here is a chart that will quickly extract any root of any number with equal ease. One root is no more difficult or time-consuming than the other. It will even extract a fractional root such as the 3½ root, 5.75 root, etc., which many capable mathematicians would have difficulty in solving by "longhand."

This chart may be used as it stands, or, if you prefer to make your own, lay off a logarithmic line AB as long as you wish—up into the millions, if desired.

Then lay an ordinary scale alongside of it like AC so that "zero" in the scale coincides with the "one" in the logarithmic line just as shown here. AC may be placed at any convenient angle with AB.

Let us now try the device and extract, say, the sixth root of 729. With the eye the position of 729 is closely located on the scale AB. Then run a straight line through the 729 and the 6 line AC as indicated by the dotted line "YY."



ANY ROOT OF ANY NUMBER MAY BE EXTRACTED BY THIS CHART

Now draw the line "XX" through the "1" parallel to YY.

The answer is given in line AB as 3. In other words 3 is the sixth root of 729.

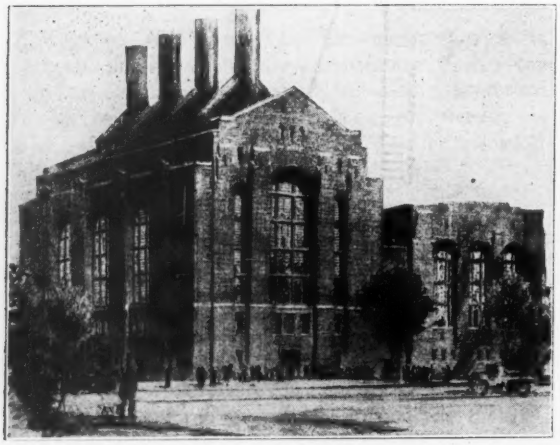
Proceed similarly for any root. Always draw the parallel line "XX" through the figure "one" in line AC. The intersection with line AB then gives the answer.

A PRESSURE GAGE testing outfit is a mighty good investment for any steam plant. Once purchased it should be used regularly.

City of Detroit Builds Morrell Street Station

MUNICIPAL PLANT OF 150,000-KW. ULTIMATE CAPACITY, BURNING PULVERIZED COAL, WILL SUPPLY POWER FOR DETROIT MUNICIPAL ELECTRIC RAILWAY

AT THE present time the Detroit United Railway, owned and operated by the City of Detroit, obtains about three-quarters of its electric power from the Detroit Edison Co. Construction has been begun by the City of Detroit, however, on the new Morrell St. municipal power plant, which will eventually furnish all the power for these railways, in the City of Detroit proper, while the Detroit Edison Co., on account of its existing distribution facilities, will continue to serve the D. U. R. lines in the



MORRELL STREET STATION OF THE CITY OF DETROIT AS IT WILL APPEAR WHEN COMPLETED

outlying suburban and interurban districts. The Morrell St. Station is designed for an ultimate capacity of 150,000 kw.; the initial installation, on which work is now progressing rapidly, will be 60,000 kw. The station will be located on the Detroit River at the foot of Morrell St. and Jefferson Ave. West, about 3 mi. from the center of the city.

The first generating unit is expected to go into operation about Jan. 1, 1927.

Generating units for this initial 60,000-kw. installation will consist of three 20,000-kw., single cylinder turbo-generators, with double flow exhaust. These units are expected to have a steam consumption of about 9.5 lb. per kw-hr. Space is provided in the initial power house building for a fourth similar unit.

Steam for the three initial turbo-generators will be supplied by six cross-drum, water-tube boilers, each with 9700 sq. ft. of heating surface. Steam is generated at 400 lb. absolute pressure, with a total temperature of 725 deg. F. Each boiler is equipped with a superheater of the combined radiation and convection type, the combination being used to secure practically constant superheat over all ranges of boiler ratings. Each convection superheater has a heating surface of 3420 sq. ft. and the radiant type of 219 sq. ft.

Each furnace will be partially lined with 1200 sq. ft. of fin-type water walls; these water walls will cover the greater part of the side walls and the lower half of the rear wall, the upper half of the rear wall being occupied by the radiant superheater. The front portion of the side walls and the front wall will be hollow, so that air for combustion can be preheated by passing through them. The lower part of the furnace will be equipped with a slag screen. The furnace is designed to burn a maximum of 23,000 lb. of pulverized coal an hour.

Power operated ash gates are provided and ash will be dumped into an ash conveyor which will load into specially built automobile truck trailers; the ash will then be hauled away, no ash storage being provided. Space is allowed at the bottom of each stack for ash collectors, but these will not be installed at first.

The station is located so that coal may be delivered to it either by rail or water but, for the present, coal will be taken only from railroad cars. From the track hoppers the coal will pass on a belt conveyor to the breakers, thence to the green coal bunkers and from there to the driers and pulverizers of the pulverized fuel system. Pulverized coal will be fed to each furnace through five feeders, each feeder supplying two fan tail burners, a total of 10 burners per boiler.

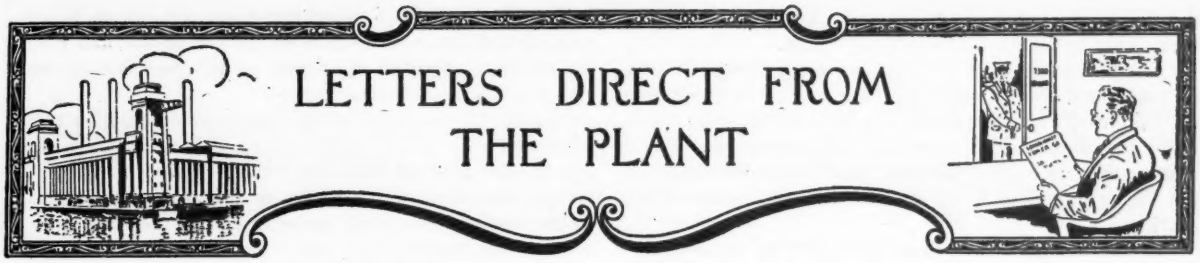
Flue gas from each boiler passes through a 5016-sq. ft. steel tube economizer, the tubes of which are lead coated inside and out. This economizer takes water previously heated to 285 deg. F. by bled steam from the turbines, discharging it into the boilers at 335 deg. F. Leaving the economizers, the flue gas will pass through parallel-plate type air preheaters where the flue gas temperature is reduced to about 250 deg. before entering the stack; the temperature of the incoming combustion air will be raised by the preheaters to 215 deg. when the boilers are operating at 300 per cent of rating. Condensers are of the two-pass type, of 27,000 sq. ft. surface each. Condensate from these passes to extraction heaters, for which the turbines are equipped with bleeder connections. Evaporators are to be installed to distill make-up water to mix with this condensate. Water will be fed to the boilers by centrifugal boiler feed pumps, three pumps to be driven by variable speed d. c. motors and two standby emergency units to be turbine driven.

All the important auxiliaries in the Morrell St. Station are to be driven by d. c. motors, power for which will be furnished by a motor-generator set. For starting up the station and for emergency use, a small d. c. auxiliary turbo-generator set will be installed.

The main turbo-generator units will produce a. c. at 13,200 v., which will be stepped up to 24,000 v. and transmitted through underground cable to 18 automatic railway substations, distributed over the system. At these stations it will be converted to d. c. by rotary converters, the voltage in the downtown sections being 500 and that in the outlying sections 600.

Contracts for the above equipment, as well as for the steel work of the superstructure and for yard improvements at the station site have recently been let. After the Morrell Street Station is put into operation, it is planned to abandon the present municipal lighting plant on Atwater Street.

F. R. Mistersky, general superintendent of the Public Lighting Commission of the City of Detroit, and L. J. Schrenk, assistant superintendent, are in direct charge of the work on behalf of the city. Smith, Hinchman & Grylls of Detroit are architects and engineers of the project.



Ice Machine Repaired by Novel Method

WE were once faced with the problem of making quick repairs to three cracks in the head of the generator on an absorption ice machine. The generator was 8 ft. in diameter, 30 ft. long, and contained eight 2-in. coils for heating the ammonia with exhaust steam. Steam entered at the top and was discharged through the bottom row.

As shown in Fig. 1, cracks appeared in the front head between the center four coils. This head was of cast iron, 3 in. thick, and was held in place by 48 2-in. bolts. At points where the coils passed through the head, tight joints were made by means of stuffing-boxes.

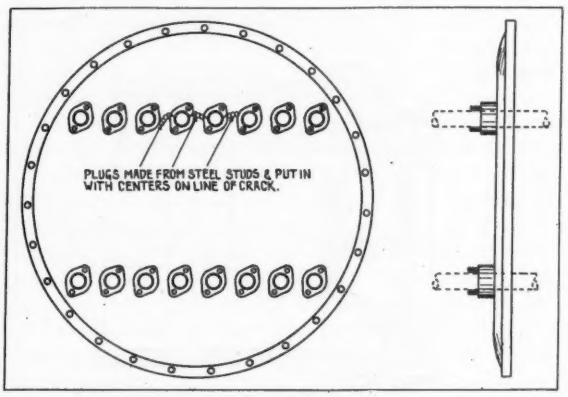


FIG. 1. FRONT AND SIDE ELEVATION OF GENERATOR HEAD. CRACKS IN HEAD BETWEEN STUFFING BOXES IN CENTER OF UPPER ROW

To stop the leaks in the cracks we drilled a row of holes, directly in the center of each crack. Using a 13/32-in. drill, the holes were drilled in each crack with 11/16 in. between centers and then tapped for standard ½-in. machine bolt threads. Studs, with threads long enough to reach through the entire thickness of the head, were then screwed into each hole and cut off even with the face of the generator head.

After this we went across the back, drilling holes in between each of the studs already in place. Finally, after studs were screwed in these holes and cut off as before, the ends of these studs were riveted along the entire length of the cracks, on both sides of the generator heads.

To stop leaks around the stuffing-boxes, these were bored out ⅜ in. larger and short sleeves of 3/16 in. thickness and of the same inside diameter as the outside diameter of the tubes, driven into the stuffing boxes and allowed to extend through the generator head far enough for nuts to be screwed on. Gaskets were slipped over each of these sleeves and washers and nuts then held the gaskets tight against the inner surface of the generator head.

On the outside, gaskets were also slipped over the sleeves and the packing glands then drawn up.

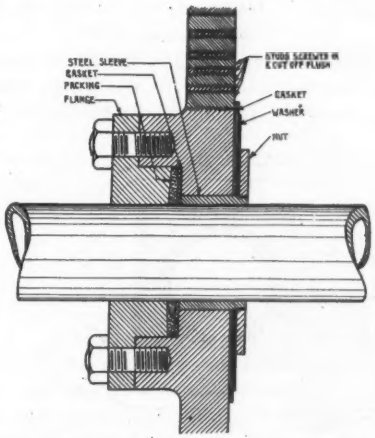


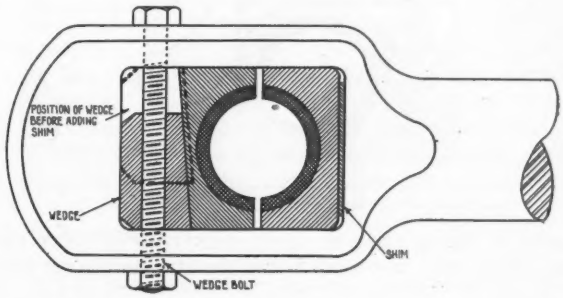
FIG. 2. CROSS SECTION THROUGH STUFFING BOX SHOWING STUDS USED TO FILL CRACK BETWEEN BOXES AND STEEL SLEEVE FOR STOPPING LEAK FROM WITHIN THE BOX

At 300 lb. pressure no sign of leaks was evident and the machine is still giving service, although it has been several years since the repairs were made.

Kansas City, Kan. J. F. STALEY.

Broken Wedge Bolt Caused by Misalinement

IN the Oct. 15 issue, p. 1065, I note an article by J. A. Madsen on wedge bolts breaking in a crosshead.



SHIM IS PLACED BETWEEN ROD AND INNER HALF OF BEARING, BEVEL OF WEDGE IS NEXT TO BEARING

Perhaps I may assist in determining the cause and suggest a remedy, as we once had the same trouble on a large air compressor. At first the wedge bolts broke about once a week, but finally it was decided to place a shim between the rod and the inner half of the bearing, thus bring-

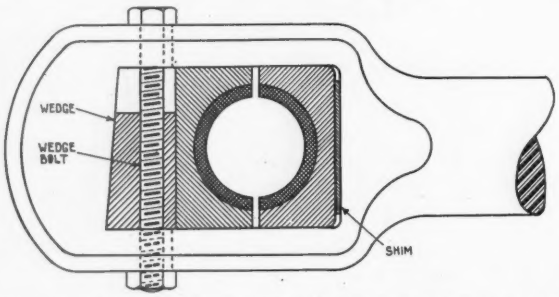
ing the wedge lower in its position. The position of the shim is shown in the accompanying figure.

The wedge had been too high to allow a straight thrust of the crank on the bearing. This caused the wedge to rock slightly, crystallized the bolt and caused it to break. After the shim was inserted, the compressor ran several months without further trouble. In all cases the center of the wedge should be about in line with the center of the bearing.

Larger wedges were ordered for a few of our compressors, but they were found too large, so the old ones were put back without the shims; the result was that the bolts broke inside of a week. Shims were again inserted and we seldom have any trouble with broken wedge bolts

Detroit, Mich. C. H. Root.

Due to a similar experience, I am of the opinion that the holes in the rod and that in the wedge were out of line. In my case, the trouble was remedied by inserting

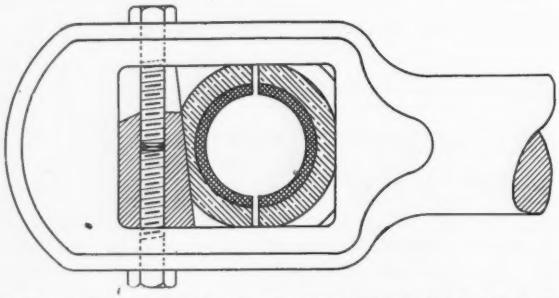


SHIM IS PLACED BETWEEN ROD AND INNER HALF OF BEARING, BEVEL OF WEDGE IS NEXT TO ROD BUT BOLT HOLES IN ROD ARE SLOTTED

a thin metal shim between the bearing and the rod; slots were, of course, provided in the rod so that the bolt could move forward as the wedge was drawn up. This is shown in the accompanying figure.

Minneapolis, Minn. A. L. Johnson.

It is little wonder that the bolt bent when the wedge was drawn up, since as shown in the original drawing, the



BEVEL OF WEDGE NEXT TO BEARING INSTEAD OF NEXT TO ROD. BOLT WILL NOT BEND WHEN BEARING IS DRAWN UP.

slope of the wedge is on the wrong side. It should be made as shown in the accompanying figure.

Pine Bluffs, Wyo. E. H. Harvey.

If the connecting rod and crankpin box are constructed exactly as illustrated in the Oct. 15 issue, the design is evidently faulty. When keying up this bearing, instead of the wedge forcing the back half of the box ahead it tends to force the end of the connecting rod out, which is impossible and thus puts a strain on the keying bolt and when the engine is running, the strain on this bolt is increased and subsequently broken.

Using the original design, the trouble could be remedied either by cutting slots in the rod to allow the wedge bolt to slide forward when the wedge is pulled up or by reversing the slope of the wedge so that this slope is next to the bearing instead of the outer end of the rod.

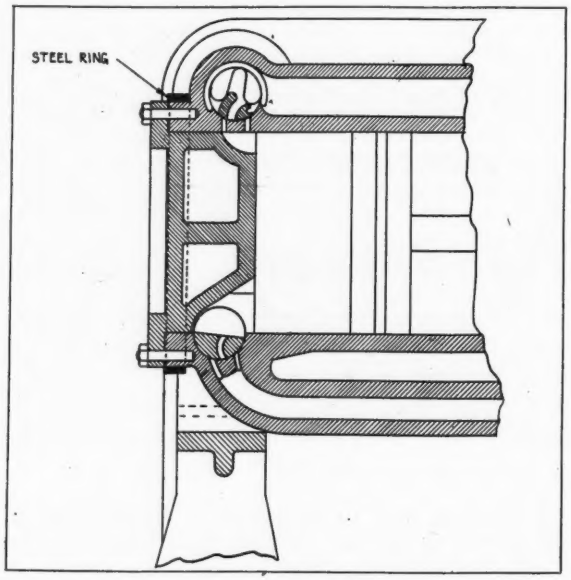
Collingswood, N. J. G. E. Taylor.

Such a device may have prevented a shutdown but if Mr. Madsen will check the alinement of the hole in the wedge block and the holes in the strap, he will probably find them out of line, throwing undue side strain on the bolt and causing it to break.

Mason City, Iowa. Clyde Stilwell.

Cylinder Head Repaired by Simple Means

When the cylinder head of an ammonia compressor engine was knocked out, cracks in eight different places were found where studs had been torn from the cylinder.



STEEL BAND IS SHRUNK ON END OF CYLINDER TO CLOSE CRACKS

It was found that sixteen 1½-in. studs were needed and it was necessary to drill deeper holes except those just in front of the admission and exhaust valves.

These studs were sufficient to hold the head in place, but with eight cracks at various points between the studs something had to be done, not only to close these cracks but to strengthen the studs. Accordingly, as shown in the accompanying figure, a band of 1 by 3 in. steel was made slightly smaller than the diameter of the cylinder projection, heated to a light red color and then driven on. Little driving was required and after gradual cooling, the cylinder was found perfectly tight. It should be noted that we had to do considerable trimming on the end of the cylinder to get a smooth circular surface on which to shrink the steel band.

This repair was made about 7 years ago and the engine is still running satisfactorily.

Kansas City, Kan. JOSEPH F. STALEY.

Point of Steam Admission Between Two Limits

IN THE ARTICLE by Richard H. Morris, page 1114, Nov. 1 issue, there are several interesting points similar to my own experience. Some years ago I made experiments on a number of steam engines in relation to valve lead and compression. As Mr. Morris invites further discussion on the subject, perhaps a brief recital of my experiments may be of some value to others.

At the time the experiments were made, I was chief engineer of a 10,000-hp. railroad power station, in which were a number of tandem and cross-compound Corliss condensing engines. On taking charge of the station I was not quite satisfied that the engines were operating as economically as they should, so experiments were started, and conducted over a period of time, with the object in view of finding the best lead to give the steam valves, the best receiver and compression pressure to run with. It seemed to me at the time that most engineers were prone to give engine steam valves too much lead, carry too low receiver pressure, and give too much compression to their engines—these, for no other reason than "that was the way the erecting engineer left the engines" or "that that was the way my grandfather ran steam engines."

So, taking one engine at a time, indicator diagrams were taken, analyzed, and calculated for power distribution between the high and low pressure cylinders. It is not my intention to present any numerical data relative to the experiments, nor to give any dimensions, for I wish only to refer to final results, and that in a most general way.

When we considered that the real purpose of giving a steam valve lead is to fill the clearance space in the cylinder with steam at the initial pressure, and not to cushion the piston, we found that we could reduce the lead materially, and we did so with considerable success. It would be of no use to give actual dimensions, since with different engines the amount of lead must be different. But we did learn from the experiments to give as little lead as possible, consistent with having initial pressure in the clearance space, just as the piston was about to start on its stroke, from "dead center" crank position.

Slow speed engines do not need any lead at all. One of the finest running engines that I ever saw—in one of the big hotels in New York City—had the steam valves set "line and line" as we say, with no lead at all. This engine was not even considered a slow speed engine.

The next step in the experiment was to find at what receiver pressure the engine was to be run for best results. Compound engines (of two cylinders) with boiler pressures at 125 lb. to 180 lb. carry the receiver pressure at 5 lb. to 15 lb. gage. The receiver pressure has probably been decided upon by the designer, or perhaps by the erecting engineer at the time of installation. Sometimes the valve adjustments are made to obtain a receiver pressure at which the engine seems to run most evenly and quietly. This may or may not be the most suitable pressure to carry.

In our experiments we began with a low receiver pressure, and by gradually increasing it with a given fixed load on the engine, caused the governor to run in the highest plane. In the meantime, indicator card readings were taken each time the pressure in the receiver was increased. In this particular case we started with 5 lb. receiver pressure, and increased it by 5 lb. each time, until we reached 25 lb. at which time the governor floated in the highest plane, while the load was kept constant by manipulations at the switchboard during the test. So for that engine, with its customary boiler pressure of 150 lb. and a cylinder ratio nearly 4 to 1, we found 25 lb. receiver pressure enabled us to carry the load with the least expenditure of steam.

The final step in the experiments was relative to the matter of compression. Suffice to say that we cut down the compression so that the diagrams showed but a slight rounding at the corners, with this change, there was no tendency for the engine to pound or to heat any of the bearings.

Now, after we had settled those three things with the first engine we repeated the performance with all the others in the plant. Summarizing:

1. We reduced the lead to a minimum.
2. We increased the receiver pressure (particularly in the tandems).
3. We reduced the compression in all cylinders.

The final result was a marked improvement in the economy of the station as a whole. This went right back to the coal pile, for it was noticeable that although the load on the station did not change, the quantity of coal consumed was less. Other conditions in the station were the same during the experiments, so the improvement evidently was due to the three changes.

After all, there was nothing wonderful about it, for upon due thought the results obtained were only what should be expected.

Brooklyn, N. Y. CHARLES J. MASON.

Burning Out Motor Is Expensive

Two or three years ago, I tried to learn from several sources the cost of electric motor burn-outs, but was unsuccessful in my efforts. There seemed to be no information on the subject.

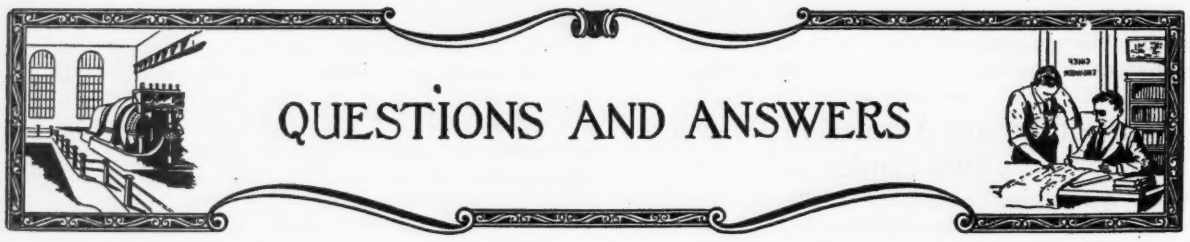
Just recently, some figures have come into my possession concerning a factory in which nearly 5000 electric motors are operated—the total power consumption being slightly over 40,000 hp. To be exact, the average of each motor is figured as 8.92 hp. The statement shows that the average is over 100 burned-out motors per year. From the total cost of rewinding the motors, I find that it amounts to $83.80 for each motor burned out.

Nothing is said about the other costs such as the cost of holding up production and idle labor during the breakdown period. But the above information alone should be valuable and interesting to all users of electrical motors. Possibly, some readers have further facts regarding the cost of repairing burned-out motors.

Newark, N. J. W. F. SCHAPHORST.

DON'T TIGHTEN the packing glands on centrifugal pumps too tightly, as the packing will wear grooves in the pump shaft, after which it will be practically impossible to prevent leakage.

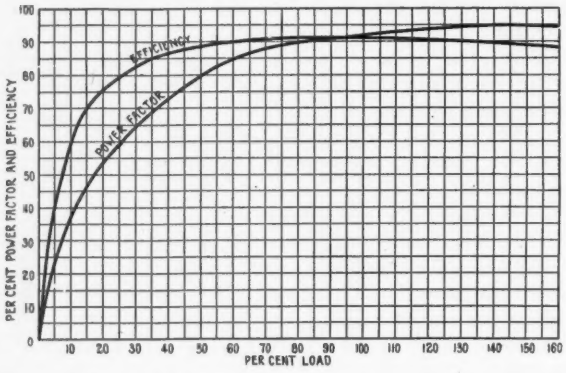
IN THE OPERATION of any CO_2 recording apparatus, the secret of success is to keep the joints in the piping system tight. This may be done by the liberal use of shellac in making up the pipe joints.



QUESTIONS AND ANSWERS

Motor Efficiency Highest at Full Load

WE have a 50-hp. induction motor driving a pump which requires only a 25-hp. motor. Does the 50-hp. motor use more current to run the pump than a 25-hp. motor? If so, how much more? F. R.



AVERAGE SHAPE OF POWER FACTOR AND EFFICIENCY CURVES FOR 3-PHASE, 25 TO 50-HP. INDUCTION MOTORS

A. Since we do not know the particular characteristics of each of the motors and the system of current distribution, we cannot give you exact figures. With the same voltage and the same system of current distribution, the ratio of current used (amperes) with a 50-hp. load, as compared to a 25-hp. load, will be as X is to 1, where

$$X = \frac{50}{\text{p.f.} \times \text{E}} \div \frac{25}{\text{p.}_1\text{f.}_1 \times \text{E}_1}$$

p.f. $\times$ E = power factor times efficiency for 50-hp. motor.

p.$_1$f.$_1$ $\times$ E$_1$ = power factor times efficiency for 25-hp. motor.

In the accompanying figure is shown the average shape of curves for power factor and efficiency of 25 to 50-hp., 3-phase induction motors.

Since it is apparent that the 50-hp. motor is operating only at one-half load, we can only compare the current it is using at this load with what it would use at full load. From the curve at full load

$$\text{p.f.} = 0.92$$
$$\text{E} = 0.91$$

At half load

$$\text{p.}_1\text{f.}_1 = 0.80$$
$$\text{E}_1 = 0.88$$

$$X = \frac{50}{0.92 \times 0.91} \div \frac{25}{0.80 \times 0.88} = 1.68$$

This means that the number of amperes is only 1.68 times as much at full load as at half load as applied to motors whose characteristics are approximately the same as those shown in the curves.

Measuring Flow of Compressed Air

ALL over the plant there are numerous small leaks in our compressed air lines. How can I measure the amount of air being wasted? J. B.

A. If you can estimate the diameter of the openings, and knowing the air pressure, the approximate flow may be calculated in cubic feet of free air per minute by a formula discussed later on. By free air, as the term is commonly used, is meant air at atmospheric pressure and at ordinary temperature. It is air in the same state as first admitted to the air compressor.

Most of the tables published by manufacturers of air compressors give the flow of compressed air into cubic feet of free air at atmospheric pressure of 14.7 lb. absolute and temperature of 60 deg. F.

	Diameter of Orifice, Inches							
P	1/64	1/32	1/16	1/8	1/4	1/2	3/4	1
	Discharge in cu. ft. free air per min., 60 deg.							
10	.084	.34	1.36	5.45	21.80	87.0	196.0	350.0
20	.119	.49	1.93	7.70	30.80	123.0	277.0	494.0
30	.156	.63	2.52	10.00	40.00	161.0	362.0	645.0
40	.190	.77	3.07	12.27	49.10	196.0	442.0	785.0
50	.225	.91	3.64	14.50	58.20	232.0	522.0	930.0
60	.260	1.05	4.20	16.80	67.0	268.0	604.0	1070.0
70	.295	1.19	4.76	19.00	76.0	304.0	685.0	1216.0
80	.330	1.33	5.32	21.20	85.0	340.0	765.0	1360.0
90	.364	1.47	5.87	23.50	94.0	376.0	843.0	1500.0
100	.40	1.61	6.45	25.70	103.0	412.0	925.0	1645.0

DISCHARGE OF AIR INTO THE ATMOSPHERE FROM INITIAL PRESSURE P IN POUNDS PER SQUARE INCH (GAGE)

Flow of compressed air may be determined by the accompanying table or it may be calculated by the following formula:

$$Q = F \frac{P}{\sqrt{T}}$$

where,

Q = cu. ft. free air per min.
F = factor, see accompanying list
P = absolute initial pressure, lb. per sq. in.
T = absolute initial temperature

LIST OF FACTORS

Diameter of Orifice in Inches	Factor
1/64	0.08
1/32	0.31
1/16	1.25
1/8	5.10
1/4	20.38
3/8	45.80
1/2	81.50

¾	183.20
1	326.00
1½	734.00
2	1304.00

Assume, for example, that you have 10 leaks, each averaging ⅛ in. diameter, the temperature of the initial air is 60 deg. F. and the pressure 100 lb. (gage).

By the formula

$$Q = 5.1 \times \frac{115}{\sqrt{520}} = 25.7 \text{ cu. ft. per min.}$$

Then, the total amount for 10 leaks will be 257 cu. ft.

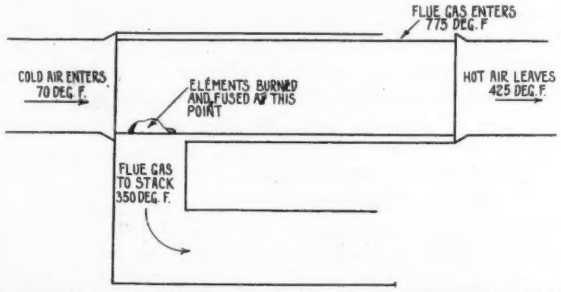
If the temperature of the air in the lines had been higher than 60 deg. F., then the amount of leak would have been proportionately smaller. With this condition, in order to correct to 60 deg. and so check with the table of air flow, the amount would need to be multiplied by

$$\frac{460 + \text{air temp.}}{520}$$

What Burned the Heaters?

In one of our industrial processes, air for combustion in both oil and stoker fired furnaces, is heated by means of the flue gas. Cold air from the outside is passed through a standard plate type air heater, as shown in the accompanying sketch.

This heater consists of a steel casing in which are contained a number of steel plate elements spaced about 1½ in. apart. Air is forced through the elements by means of a blower. Air and gas flow in opposite directions.



SIDE ELEVATION OF PLATE TYPE AIR PREHEATER. SOOT DEPOSIT CAUSED BY CHILLING ACTION OF ENTERING AIR BELIEVED CAUSE OF DAMAGE

In several instances we have found these heaters badly burned at the point where the flue gas leaves the heater. Evidence has shown that in some cases the heat has not only badly burned the elements but has even fused the steel. At first it seemed strange that the heaters should be burned at the point where both the air and gas was coldest, while at the other end, where the flue gas was hottest, there were no signs of damage. Later it was discovered that there was a definite connection between smoky fires and the burning of the heaters, since a heater which had just been inspected before firing was found badly burned directly after smoky fires were noticed.

Our theory is that soot from the smoky fires is carried through the heater until it reaches the point where it is chilled by the cold air entering. This causes it to be deposited on the surface of the elements. With the elements coated with soot at this point, any spark carried through the heater will ignite the soot and the intense heat evolved will burn the thin sheet steel as if it were tissue paper.

Firemen have been instructed to avoid smoky fires and we have had no more trouble with burned heaters.

We shall appreciate comments from readers as to their theory of the cause of the trouble. Perhaps others have had similar experience and will tell us about it.

Chicago, Ill. O. C.

Cooling Water for Diesels Depends on Load

What is the average amount of cooling water required in the jackets of Diesel engines? P. S.

A. The amount of cooling water required varies inversely with the difference in temperature of the water as it enters and leaves the jackets. It also varies with the load on the engine. Assuming a 40 deg. rise from suction to discharge temperature, from 6 to 7 gal. per hp-hr. are required.

When fairly pure water is available, the discharge temperature may be maintained at 140 deg. F. If, however, the water has a tendency to deposit scale in the jackets, the discharge temperature should not be over 120 deg. F. For this reason, and particularly for hot climates where the temperature of the inlet water is too high, it is desirable to provide for cooling water supply of from 10 to 12 gal. per hp-hr.

Calculation of the amount of cooling water may be made as follows:

$W = XH \div 100\ (t^1 - t^2)$

where,

W = Pounds of water required per hp-hr.
X = Per cent heat in fuel absorbed by the water
H = Heat value of the fuel multiplied by pounds fuel consumed per hr.
t^1 = Discharge temperature of water
t^2 = Inlet temperature of water.

Amount of Vacuum for Heating Systems

How much vacuum should be carried on vacuum heating systems? W. E. F.

A. In vacuum heating systems only enough vacuum should be carried to insure a prompt removal of air and water from the radiator and to lower the initial steam pressure in the heating system to approximately that of the atmosphere. Ordinarily a vacuum of about 2 in. is carried at the most distant radiator. This may require a vacuum ranging from 3 to 4 in. to 20 in. at the pump, depending upon the lift and length of run. Under average conditions, however, this will not exceed 8 or 10 in.

Carbon Dioxide Restricted as Refrigerant

Why is carbon dioxide not used extensively as a refrigerant? C. R.

A. One of the principal reasons is its low critical temperature, which is approximately 88 deg. F. No amount of pressure above this temperature will cause it to liquefy. Accordingly, to get proper heat transfer, condenser water temperature should be at least 10 deg. lower than this.

Ammonia has a critical temperature of about 270 deg. F., so that much warmer condenser water may be used. Need of such relatively cool water restricts the use of carbon dioxide to comparatively few plants.

Condensate from the World's Power Plant

ANALYZED FOR QUICK STUDY AND COMPARISON. BY WILLIAM SIBLEY

Aerial Transportation Will Develop Rapidly

William B. Stout, who is the directing head of the air division of the Ford Co., is the man who sold the Fords the airplane idea and this idea is now being backed by the Ford millions. Already the division has grown to sizeable proportions and has machines in regular schedule service between Ford plants located in Detroit, Cleveland, Dearborn and Chicago, carrying freight as well as private mail matter and express. Extensions of the system are being actively pushed.

Mr. Stout recently prophesied the development of air transportation in the United States, saying: "By the end of 1930, the country will be honeycombed with air lanes. Ships carrying 1 and 2 t. of freight by air will be performing important service and multiple engine ships will be in regular trans-Atlantic and trans-Pacific service. It was but a few years ago that the Atlantic was crossed by airplane but trans-oceanic service is coming fast. Direction will be by wireless rather than by marks and lights. Ground lights are sometimes rendered useless by weather conditions; they have their uses and flood lights will always be needed at landing fields but radio is far more dependable.

"Privately owned ships will have capacities of 2 to 7 passengers, their popularity increasing as we develop facilities for landing. Airplanes will be lighter and longer lived with air-cooled engines. Price will be regulated by demand. Motor cars used to be expensive; now they are cheap because of public acceptance and demand which have made possible quantity production."

Ford planes in freight carrying are already saving, in time and money, the equivalent of $1000 a week on the Dearborn-Chicago line. If this economy can be effected with the present high cost of planes and operation, it is interesting to conjecture what will be the saving to industry when 50,000 planes have been put into daily service and 50,000 is not a large number when we compare it to the 17,000,000 odd automobiles now in daily service.

Building Activity Catches Up With Normal Growth of the Country

Building activity is so interwoven with the whole commercial structure that a high rate of building goes far toward assuring good business and slowing down of building retards general prosperity. From such data as are available, it would seem that, with the close of 1925 shortages accumulated during the war will have been wiped out. It would seem, therefore, that 1925 will probably be seen as the peak year in the present building cycle and from 1926 on, building will be at a rate commensurate with the natural growth of population and business demands.

Normal building was brought to a standstill by the mobilization of resources during the war and the building completed during 1919 and 1920 was largely industrial work to take care of the post war boom. Depression in 1920 and '21 slowed down the pace until lower price levels encouraged builders to tackle the problem again. Real advance against the building shortage began in 1922 and has shown substantial gains since until this year contracts totaled over 4½ billions of dollars, 2 billions being for residential construction.

Spite of the fact that war shortages have been made up, building is likely to continue at only slightly lower rate than in the past. It is estimated that between 3½ and 4 billions are required annually to care for normal growth and expansion. During the last 5 yr., spite of the restrictions on immigration, the increase in families has been estimated as 2,200,000 and industrial expansion has been marked. There is a distinct shortage of educational housing facilities in many sections of the country. There is every indication for the coming year of healthy activity.

Great Climatic Changes Are Taking Place

Along the western slopes of the Andes Mountains traces still remain of a pre-Inca population, proving to scientists that the territory now called Peru was once the home of a highly civilized race. This would indicate that the territory which for 2000 years has been dry was once well watered.

During the past twelve months this desert has been transformed into a tropical paradise. Dry river beds, in which towns and villages have stood for hundreds of years, were turned into raging floods, destroying thousands of homes and pouring sufficient water into the sea to freshen it for miles off shore. This flooded area includes portions of Bolivia, Peru, Ecuador and northern Chile, which, prior to last November, had been desert as far back as white men can remember.

From these events in Peru it would seem that the dogma that climatic changes can come only by slow gradations is, in the parlance of the day, "all wet."

Herbert J. Browne, lifelong student of climatology, explains the phenomenon in this wise: "Oceans cover 0.7 of the earth's surface and furnish 0.9 of the moisture precipitated on the land, having a very definite effect upon continental weather conditions. In the southern hemisphere oceanic areas are far in excess of land areas, the Antarctic Ocean extending in an unbroken sweep around the globe and encircling the Antarctic continent, which is much larger than Australia. It is almost entirely a high plateau, some 10,000 ft. in elevation and here the great southern high level air movement concentrates from the Equator and descends, forming a huge barometric high-pressure column, from which winds radiate spirally outward in westerly gales encircling the globe. These are the dominating air currents of the world, merging to some extent to form the warm currents of the northern hemisphere.

"Greatest of our ocean rivers is the Humboldt Current. Antarctic water, rebuffed by the extremities of South America and South Africa, has only 10 deg. on the meridian through which to make its easterly flow. Hence it feeds this current a volume of cold water 500 mi. wide and 2 mi. deep with a seasonal velocity as high as 4 knots an hour.

"Early in 1923, due to the lowering solar constant, an increasing volume of cold water was poured into the current, greatly lowering its temperature, a condition which continued to accentuate until November, 1924. At this time El Nino, a small southern current, which usually becomes active about Christmas and originates in the warm waters of the Bay of Panama, began flowing southward inshore along the coast of Peru and Ecuador. At the same time winds, which are generally off shore, switched under the influence of the cold Humboldt current and carried immense volumes of highly humid air from El Nino over the land to the western slopes of the Andes where they condensed into rain."

Much as we might deplore the destruction of the nitrate beds in Chile and Peru, which are threatened by the floods, this is secondary to the interest in Mr. Browne's belief that these conditions are but a forerunner of climatic changes reaching over large areas of the globe. He believes that, if the Peruvian rains continue, as he thinks they will, similar reverses will be felt throughout the high plateau of Mexico and will extend northward to southern California, Arizona and New Mexico.

One has difficulty in thinking of Arizona and New Mexico as blessed with 30 in. of rainfall, which Mr. Browne predicted in his forecast. This would mean for that country alfalfa, small grains, peach treas and orange groves.

It is hard to believe. But the Smithsonian Institute, Mr. Browne, Dr. Cushman Murphy and a score of eminent English and European scientists are developing a new and valuable science that has already proved itself worthy of serious consideration because of its accuracy. Certainly we of the unstudied in such matters will do well to consider these predictions and possible consequences.

Sometimes Our Sympathies Are With China

You probably won't believe this article, but read it anyway. It gives a few interesting side-lights on why the Chinese resent the presence of foreigners. While reading, it is well to keep in mind the fact that, in China, Americans are foreigners.

We sometimes wonder why China is continually in a state of chronic insolvency. There are several reasons for this, one of which is:

China is the greatest potential market for international trade on the globe. Her rich mineral deposits, her forests, her water power, indeed each of her natural resources is virtually in a virgin state. This undevelopment attracts the foreign industrialist who sees the possibilities of developing railways, mines and manufacturing plants—with the view, naturally, of eventually controlling them. This is the usual procedure: Promoters or representatives first sell the idea to wealthy Chinese. Then they get the Chinese to borrow large sums of money for the development of the project, always with the stipulation that the creditors shall have a share in the management. When financial troubles arise (which are frequently manipulated) and the Chinese are unable to meet their obligations, the project, as a matter of course, reverts to its creditors.

The Han-yeh-ping Iron and Steel Co. in Hankow, for instance, is now dominated by Japanese. Since assuming control, pig iron and ore up to a specified amount is sold to the Imperial Works in Japan at much below the market value. The result of many such experiences with many foreign nationalities has made the Chinese wary of foreign enterprise and has made them prefer to let opportunities slip by and their mineral wealth lie fallow, rather than become involved with the risky foreigner.

Under the existing treaties, China has no power to determine her own tariff. The uniform 5 per cent ad valorem duty on all goods was fixed by foreigners many years ago and has since remained in force; this, in spite of the sharp advances in world prices of practically all commodities. The existence of this low tariff makes it impossible for the native, on his own soil, to compete with the foreign importer.

All Chinese harbors are leased to foreign powers—the leases compelled, in times past, at the point of a bayonet. Today there is no harbor or port in the 300 mi. of Chinese coast line in which China could mobilize her ships.

Shanghai is the most uniquely governed city in the world. It is jointly ruled by every country in the world but China. It was established about 80 yr. ago by a few British traders sailing up the Whangpo. Rapidly it became a large foreign settlement and, during the Civil War, Americans took their place among the others at this point. The Chinese government was compelled, by force, to yield virtual ownership of the land to the foreigners, who had by that time inaugurated courts and set up a municipal council according to western custom. Last year's census showed the foreign population, including Japanese, Siamese, Indians, etc., as well as the white races, to be 21,657. The Chinese numbered 827,932. This is a ratio of about 40 to 1 in favor of the Chinese, who own most of the property of the settlement, conduct the bulk of the retail business and pay nearly 75 per cent of the taxes of that settlement. Yet these 800-odd thousand Chinese, which includes ex-ambassadors to foreign cities, statesmen, wealthy graduates from Oxford and Yale, have no vote and are not represented in the municipal government. Over the entrance to one of the parks (in which nightly band concerts are given at the expense of the tax-payers) there is a sign: "Dogs and Chinese not allowed." Perched over the entrance of a second park is a sign which reads: "This space is reserved for members of the foreign community."

The Washington Conference promised China that she could raise her custom tax from 5 up to 7.5 per cent. This advantage, with others, has never been realized because the Nine-Power Pact has never come into being through lack of ratification by France. This procrastination has done nothing to allay the suspicions of the Chinese for all foreigners.

Not long ago an American representative of a large newspaper asked a prominent Chinese patriot: "Is China on the verge of another Boxer outbreak?" To which question came the reply: "Unless the foreign powers change their policy toward China, a new Boxerdom is sure to come sooner or later and, when it does come, it will be something compared to which the recent earthquake in Japan will be a very small affair."

BE IT Walla Walla or Washington—Philadelphia or Podunk—Chicago or Council Bluffs; and be it capitalist or carpenter—banker or bootblack—prince or pauper, men are known by the company they keep.

THERE IS a retail store for every twenty families in the United States.

EDITORIAL COMMENT

Further Steps Toward Standardization

Reference has been previously made in these columns to the movement now going on under the guidance of the Division of Simplified Practice of the U. S. Department of Commerce to reduce the varieties and sizes of industrial materials in order to avoid duplication and to narrow the field down to those materials that have been found most adaptable to industrial requirements. In order to bring about this simplification and standardization of products, it is necessary for us to have some sort of measure by which to standardize. In an endeavor to provide such a measure, the American Society for Testing Materials is, at the present time, taking a great interest in the preparation of standard specifications and tests for a wide variety of engineering materials. Although this work is only beginning, considerable progress has already been made, as reported at the recent A.S.T.M. group committee meeting at Cleveland. An ambitious program has been laid out and many of the most prominent engineers of the country are at work on it.

For the producer, the several advantages resulting from standardization of tests may be set forth as follows. In the first place, he is not compelled to supply, for essentially the same purpose, materials ordered to a variety of specifications. In times of general business depression when his orders are low and buying is practically at a standstill, the manufacturer can continue to produce "standard" material, knowing that when business picks up, there will be a market for it. Then, too, the adoption of standards reduces the variety of commodities that must be kept in stock by producers and distributors. Finally, the producer knows exactly what he is expected to furnish and how the consumer will test and inspect the materials.

All these benefits to the producer are of advantage to the consumer, even though indirectly. In addition, the consumer experiences certain other specific advantages in the use of standard tests and specifications. He can secure truly competitive bids on the same quality of material and the details of purchasing are simplified and standardized. Standard methods of test and inspection are of particular value to the consumer in establishing a routine procedure for acceptance of material. The final result is that greater uniformity and reliability of material purchased under standard specifications make possible its more economical use.

It will be seen, therefore, that the work of the A.S.T.M. referred to above is of the greatest interest and importance to the engineer, since he is in all cases a consumer of engineering materials and in many cases both a consumer and a producer of them. In conjunction with the simplified practice movement, this work of standardizing tests and specifications is another long step toward that standardization of industrial materials that will eliminate wastes of such magnitude that industry prefers not to speak of them in exact terms but simply to say that they amount to millions of dollars in a year. Since one of the first principles of engineering is to prevent waste, our reason for emphasizing the value of standardized tests and specifications should be apparent.

Industrial Leaders Demand Less Government Competition

In Washington, on December 10, is scheduled a mass meeting of industrial leaders to protest against the constant and growing intrusion of the Government into the field of business activity. Three hundred trade associations and other industrial organizations have been invited to participate in this "rebellion of industry" as it is characterized by leaders in the movement. The full force of the meeting will be directed against the practice under which tax-paying business firms are forced to finance the Government as an active competitor and will not be opposed to Government regulation of industry.

Among the public utilities, such competition is not new; in fact, many of our utility industries were started as Government, state or community enterprises with public funds. Private and corporation enterprise, however, has forced a large majority of these publicly-owned industries out of existence by giving their customers a service at a rate with which the public enterprise could not compete. For years these public utilities were treated as political footballs by office holders seeking popular favor, until public regulation by utility commissions became established throughout the country. Today, agitation for public ownership of power plants where company-owned plants are in operation, meets with only occasional local popularity which is quite conclusive evidence that the public relations in this field are in a healthy state.

Government control of industries, other than public utilities, has not been attempted except in a desultory way during war times. Certain phases of individual corporation trade practices and association activities have come in for Government investigations and court injunctions, but no machinery has been put into operation which limits prices and regulates expansions and improvements of industries in general, as is now the practice with utilities.

In the United States, Government ownership and operation of industries has not been as satisfactory as private or corporation ownership, and where competition exists, there can be little justification for Government intrusion into the industry either as a competitor of those in the industry or even as a regulator except to prevent unfair trade practices. Regulation is submitted to by public utilities on the ground that the community gives the company a certain monopoly on the business. Just what spirit other industries may exhibit toward regulation is difficult to predict but it is to be hoped that Government authorities will, by this meeting of association representatives, be deterred from launching the country into needless competition with successful private industries.

It Can't Be Done

About a century ago, when the steam railroad was in its infant stage of development, there existed a prevalent notion among railroad men that a steam locomotive could not run uphill. Whenever a train came to a hill, the locomotive was unhooked, the cars pulled up by a winch, and a new locomotive attached at the top. Ridiculous as it may seem to us now, nobody seemed to think this strange and when William Morris, a rival of Baldwin, one day got the idea of trying it and actually demonstrated that a train *could* run uphill, nobody would believe it. Even when the editor of the Railway Journal recounted his wonderful experience of being hauled uphill by a locomotive, an indignant reader wrote in that the editor had been deceived, that the thing was an open and flagrant violation of the law of gravitation and he proved conclusively by algebra that it could not be done.

This anecdote illustrates an inherent failing of the human mind. Just because a thing has never been done before, its suggested adoption is invariably met with violent opposition from all quarters. All sorts of derogatory and contradictory evidence is submitted and many pseudo-scientific arguments are advanced to show that the proposed plan is not only against all the laws of nature and the dictates of common sense but that it is a delusion in the mind of the inventor.

Notwithstanding the retarding influence of such pseudo-scientific reasoning upon the development of any new idea, no form of mental distortion is so harmful or so repellant towards progress as the tendency to condemn a new idea, simply on the grounds that it has never been done before. Just because a thing has always been done in a certain manner is absolutely no reason for anybody to conclude that that method is the best way of doing that particular thing. Indeed, as James Harvey Robinson has pointed out in his remarkable book, "The Mind in the Making," the very fact that a thing has been done in a certain manner for an extended period of time is a good indication that there is probably something wrong with it and that alone is sufficient reason for being suspicious of it and starting an investigation.

The history of civilization is replete with instances of this hopeless form of mental inertia. Every original thinker since the dawn of civilization has had to combat it and has been compelled to force his work upon a protesting humanity. It is only necessary to mention such names as Columbus, Galileo, Harvey and Goodyear to recall to mind specific examples. When Dr. Wm. Harvey proclaimed his theory of the circulation of the blood, he was laughed to scorn and presently lost his practice.

In our own field,—in the history of power,—we have innumerable instances where new ideas were condemned and held in repression until the sheer force of their inherent logic forced their acceptance. From the time the simple folks around Philadelphia first snickered up their sleeves as Franklin set out with his kite to prove that lightning is electricity, until the present day, practically every new idea, regardless of how successful its ultimate adoption has been, was branded impractical, foolish or even impossible.

When Edison was engaged in the construction of the first central station system in New York, the project was denounced as impractical from one end of the scientific world to the other. Even the great Tyndall was skeptical and said he preferred having the problem in Edison's hands to having the responsibility for it himself. Others openly condemned it; subdivision of the electric current was impossible; therefore, the project was doomed to failure. Since the dynamos at Pearl Street first brought the crude carbon lamps in lower New York to a glow, they have never been darkened. It couldn't be done!

Within the past year has been laid across the floor of the Atlantic Ocean a new telegraphic cable, wound with a new material, Permalloy, by means of which the speed of transmission is increased enormously. Its operation is based upon the principle that a uniformly distributed inductance will neutralize the natural capacity of a cable. It works like a charm. Yet, when the late Oliver Heaviside, England's mathematical genius, voiced this thory in 1893, such an eminent electrician as Sir William Preece strongly contested the idea and professed to have proved its worthlessness by various experiments.

In our own experience within the past year, when a new idea in stage feed-water heating was presented to the engineering world, we received a communication from an individual who denounced the idea and proved by extended thermodynamic and hydraulic reasoning that the operation of the device was impossible. Yet, today, the device has passed the laboratory stage and will shortly be on the market.

These few instances are sufficiently illustrative of the mental trait which we set out to discuss. But we would be presumptuous, indeed, were we to suppose that by any mere discussion we could hope to overcome this tendency to regard anything new with hostility. It is worth thinking about, however, and it is something which we, as engineers, should keep in mind whenever we are called upon to express an opinion on a new idea or development.

A new idea is the rarest thing in the world and, while it is well to be critical, we should do all in our power to encourage the development of an idea rather than to discourage it. In the laboratory of C. Francis Jenkins, the noted inventor at Washington, there hangs a card bearing this inscription, "They said it couldn't be done, but the poor fool didn't know it, so he went ahead and did it." That, we believe, would be a good motto to hang in every engineer's office in the country.

Production of Electricity Increases

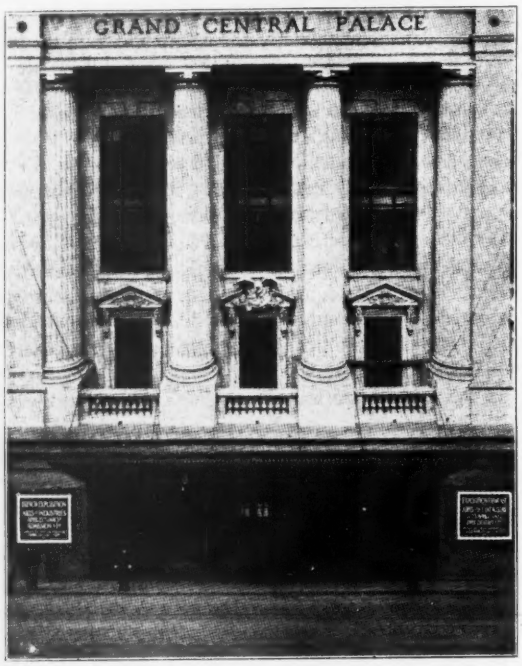
Increase in the production of electricity by public utility power plants in the United States during the past 5 or 6 yr. has been dramatically impressive. In 1919 the output of electricity approximated 39 billion kw-hr.; during 1924, it reached well over 59 billion, a gain of more than 50 per cent. Production during the first half of 1925 was over 10 per cent above the production for the like period of 1924.

Among the fuels employed in the development of electrical energy, gas and oil show the greatest relative growth. Gas consumption has increased during the past 6 yr. more than 125 per cent, oil a little more than 50 per cent, while the increase in the consumption of coal has increased only 10 per cent. In spite of the increases in oil and gas, however, coal still produces more than 80 per cent of all the electricity generated by fuel.

That we have learned much about combustion and generative power plant practice is proved by the fact that in 1919 it required 3.2 lb. of coal to produce 1 kw-hr. of electricity, while, in 1924, this requirement had been reduced to 2.2 lb.

Through This Portal Lies Progress

COMPREHENSIVE EXHIBITS, INSTRUCTIVE LECTURES AND INTERESTING MOVIES TO BE FOUND AT THE NEW YORK POWER SHOW



THREE FLOORS of the Grand Central Palace on Lexington Ave., New York City will be filled with interest for the engineer, from Nov. 30 to Dec. 5. New devices, new developments, new materials, new methods of controlling Nature's forces and utilizing power resources will be exhibited and demonstrated.

Besides the exhibits, of which a complete directory follows, a program of lectures will be featured, covering the fields of power and mechanical engineering. Fourteen lectures will be given, among them the following:

Machine Tools, by Fred Colvin, Editor American Machinist. Tues., Dec. 1, 2:45 p.m.

Steam Prime Movers, by C. Harold Berry, Associate Editor of Power. Fri., Dec. 4, 3:00 p.m.

Oil and Gas Engineering, by George A. Richardson of Bethlehem Steel Co. Tues., Dec. 1, 8:15 p.m.

Steam Boilers, by Edward R. Fish, Vice-President of Heine Boiler Co. Wed., Dec. 2, 8:15 p.m.

Industrial Power Plants, by F. M. Gibson, Plant Engr. of American Sugar Refining Co. Thurs., Dec. 3, 2:45 p.m.

Heating and Ventilating, by S. E. Dibble, Pres. American Society of Heating and Ventilating Engineers. Thurs., Dec. 3, 8:15 p.m.

Standardization, by C. E. Skinner, Chairman, American Engineering Standards Committee. Fri., Dec. 4, 3:00 p.m.

Steam Locomotive, by Clair B. Peck, Editor, Mech. Dept. Railway Age. Fri., Dec. 4, 8:15 p.m.

Other topics to be presented are refrigeration, Mechanical Power Transmission, Materials Handling in the Power Plant, and Materials Handling in Industry.

The program of lectures will be amplified with a series of motion pictures collected from various governmental and industrial sources which will bring out the spectacular achievements in the recent growth of engineering and industry. Following are some of the titles:

A Forward Step in Stoker Performance. 2 reels by courtesy of Riley Stoker Co.

From Mine to Consumer: The Story of Anaconda. 4 reels by courtesy of American Brass Co.

The Story of Brass and Copper. 3 reels by courtesy of Mueller Brass Co.

Power: Its Generation in Big Engines of Yesterday and Today: The Construction of the Weymouth Power Station. 3 reels by courtesy of Stone & Webster, Inc.

Saving Coal at Home. 1 reel.

The Story of a Motor Truck. 3 reels by courtesy of U. S. Bureau of Mines.

The Story of Asbestos. 4 reels by courtesy of U. S. Bureau of Mines & Johns-Manville, Inc.

Water Power. 2 reels by courtesy of U. S. Bureau of Mines and Westinghouse Elec. & Mfg. Co.

The Development of the Locomotive. 3 reels.

Building a 50,000-hp. Steam Turbine Generator. 1 reel.

Ships: From Sailing to Steam and Electric Motor Ships. 2 reels.

Five Big Mechanical Jobs. 1 reel.

Mining and Preparation of Anthracite Coal. 1 reel.

Mining Methods and Preparation of Bituminous Coal. 1 reel by courtesy of General Electric Co.

Refining, Production and Manufacture of Monel Metal. 2 reels by courtesy of International Nickel Co.

Building Gridley Automatic Machine Tools. Two reels by courtesy of National Acme Co.

Lectures and moving pictures will be given in the auditorium on the third floor where ample accommodations will be found.

ALPHABETICAL DIRECTORY OF EXHIBITORS WITH BOOTH NUMBERS, PRODUCTS AND REPRESENTATIVES AT THE SHOW

Accurate Brass Casting Co.—Booth 476.

Ackerman-Johnson Co.—Booth 423. Steam specialties.
Representative: W. A. Stone.

Advance Engineering Co.—Booths 275-276. Relief valves and traps.
Representatives: Chas. W. Gill, C. Wilson Gill, Robert Bristow and Roger Farr.

Aero Pulverizer Co.—Booths 319-320. Coal pulverizing equipment.
Representatives: W. W. Clinedinst and H. B. Baird.

Air Preheater Corp.—Booths 234-235. Ljungstrom air preheater.
Representatives: W. L. Batt and R. E. S. Geere.

Alexander Brothers—Booth 434. Belting.

A. Allan & Son—Booth 483. Bearing metals and packings.
Representatives: Andrew Allan, Wm. T. Allan and Harry D. Chandler.

Allen-Sherman-Hoff Co.—Booth 75. Ash handling equipment.
Representatives: Frank B. Allen, L. P. Hoff, M. C. Sherman, E. A. Brooks, George W. Stetson, James Stokoe, H. R. N. Johnson, P. H. Bird, W. P. Nevins, D. W. Simler, W. D. Bickel, R. L. Stone, A. E. Howell, J. H. Weir and E. L. Hughes.

Allis-Chalmers Mfg. Co.—Booth 470. Steam turbines and engines, gas engines, compressors, transmission equipment and special machinery.

Louis Allis Co.—Booths 445-446. Special motors.
Representative: Louis Allis.

Alsop Engineering Co.—Booth 212. Mixing machines and pumps.
Representatives: S. Alsop, Charles Crawley and Theodore

American Arch Co., Inc.—Booth 58. Suspended, renewable arches.

Representatives: H. A. Mannshardt, J. A. Lodwick, P. S. Haserodt, R. L. Ehmann and C. W. Marshall.

American Blower Co.—Booths 296-297. Forced and induced draft.

Representatives: F. R. Still, Vice Pres. and Secy., Arthur Ritter, J. F. Munder, T. L. Kennedy, Benjamin Adams, J. A. Nichols, E. F. Falk and A. Steinmetz.

American Brass Co.—Booth 65. Condenser tubes, turbine blading, wire and cables.

American Car & Foundry Co.—Booths 207-208. Industrial cars and railways.

American Chain Co., Inc.—Booth 48. Crane, hoist and transmission chain.

American District Steam Co.—Booth 475. Expansion joints, traps, meters and underground pipe systems.

Representative: Arthur J. Slade.

American Machine & Foundry Co.—Booths 429-430. Rotary pumps and water supply systems.

Representatives: C. Q. Wright, Jr., C. E. Anderson and F. Colby.

American Pulley Co.—Booths 530-531. Split pulleys, steel shaft hangers.

American Resistor Co.—Booths 524-525. Globar electric heating.

Representatives: Joseph A. Steinmetz, Walter W. Perkins, W. E. Duersten, F. D. Potenza, B. G. Tarkington, Oscar Brophy and W. J. Buff.

American Schaeffer & Budenberg Corp.—Booth 74. Gages, thermometers and temperature controllers.

Representatives: H. V. Carlier, Mr. Binz, Mr. Campbell, Mr. Undeutsch and Mr. Stark.

American Society of Mechanical Engineers—Booth 80. Publications.

Representatives: C. E. Davies, E. Hartford, C. B. LePage and W. E. Bullock.

Amercian Temperature Indicating Co.—Booth 510. Temperature indicating and recording instruments.

Anaconda Copper Mining Co.—Booth 65. Condenser tubes, brass and copper tubes and rods.

Andale Engineering Co.—Booth 92. Duplex oil and water strainers.

Representative: James T. Gordon.

Andrews-Bradshaw Co.—Booth 17. Steam Purifiers.

Arca Regulators, Inc.—Booths 213-214. Combustion and temperature control system.

Representatives: N. V. Hansell, P. S. Bolton, S. Soderberg and R. A. Sandberg.

Armstrong Cork and Insulation Co.—Booths 334-335. Nonpareil and corkboard insulation.

Representatives: R. S. Broas and C. A. Center.

Armstrong Machine Works—Booth 275. Steam traps.

Representatives: O. E. Ulrich and Charles W. Gill.

Armstrong Mfg. Co.—Booth 451.

Ashton Valve Co.—Booth 38. Safety and relief valves, whistles and gages.

Representatives: H. H. Ashton, C. W. Buckelew, C. W. Ulrick, C. D. Motheral and H. Rand.

Atwood & Morrill Co.—Booths 552-553. Special valves. Damper regulator.

Representatives: H. B. Morrill, Pres., C. P. Atwood, Treas. and B. T. Atwood, Secy.

Automatic Primer Co.—Booth 244.

Babbitt Steam Spec. Co.—Booth 90. Sprocket rims for valve operation.

E. B. Badger & Sons Co.—Booth 436. Expansion joints, strainers, cooling spray nozzles.

Bailey Meter Co.—Booth 54-55. Automatic boiler operation control.

Representatives: E. G. Bailey, Pres., H. M. Hammond, P. T. Reuter, C. R. McClure and H. C. Tanner

Ballwood Company—Booth 249. Pipe fittings for high-pressure joints.

Representatives: George A. Williams, A. H. Dirk and E. J. Hughes.

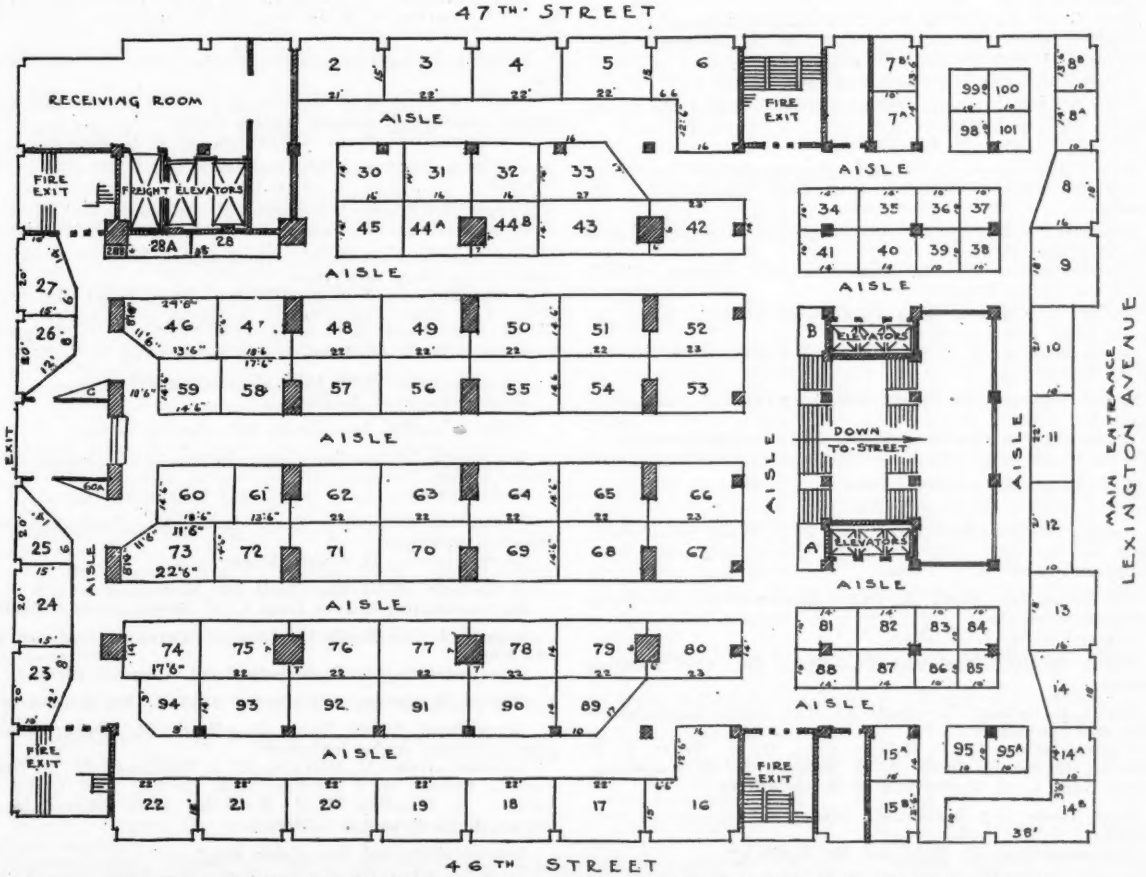


FIG. 1. PLAN OF MAIN FLOOR EXHIBITS IN GRAND CENTRAL PALACE, NEW YORK POWER SHOW

Barco Mfg. Co.—Booth 547. Flexible joints. Lubricated plug valve.
Representatives: Arthur S. Lewis and R. P. Klein.

Barnes & Jones—Booth 313. Heating system specialties.
Representatives: Walker E. Barnes, Wm. T. Jones and H. B. Eells.

Bartlett-Hayward Co.—Booths 344-345. Flexible shaft couplings.
Representatives: Gustave Fast, Hugh Benet, M. T. Maguire, H. R. Geiger, H. W. Calder, James M. Jenkins and Sol Wolff.

Bassick Mfg. Co.—Booth 550. Alemite forced grease lubrication.
Representatives: J. Guy Griffith and Walter N. Duncan.

Bayer Co.—Booth 216. Mechanical soot blower system.
Representatives: L. J. Bayer, Pres., C. P. Kelly and F. P. Rose.

Bearium Bearings, Inc.—Booth 504.

R. H. Beaumont Co.—Booths 50-51. Coal and ash handling systems and equipment.
Representatives: H. W. Ruth and H. Pluemer.

Bernitz Furnace Appliance Co.—Booth 78. Furnace lining blocks.
Representatives: Arthur E. Smith, Pres., E. R. Jefferson, D. B. Wilson, Charles H. Schroder, J. M. Nicholson and Benjamin H. Snow.

Bethlehem Shipbuilding Corp., Ltd.—Booths 70-71. Oil burning system.
Representatives: H. G. Smith, Vice Pres., A. W. Christian, J. W. Hendry, G. E. Lawrence, F. K. Steinrock, G. A. Worn, G. E. Johnstone, E. H. Codding, J. B. Briggs, J. R. White, E. H. Ewertz, W. S. Wilkinson, W. J. Denholm, Thomas Service, C. H. Garlick, Fred Schoen, H. Thomas, K. W. Heinrich, W. E. Dickey, A. B. Alsos and G. A. Richardson.

Bethlehem Steel Co.—Booths 514-515-522-523. Coal pulverizing plant. Diesel engines.

The Bigelow Co.—Booth 68. Water tube and fire tube boilers.
Representatives: G. Welter, T. C. Vincent, C. K. Redfield and P. M. Fleming.

The Bilton Mach. Tool Co.—Booth 442. Automatic milling machines.

Bird Archer Co.—Booth 464. Feed-water treatment.
Representatives: P. B. Bird, Pres., W. E. Ridenour, Vice Pres., H. V. Bootes, Secy., L. Morehouse, Treas.

Bishop & Babcock Mfg. Co.—Booth 563.

Blackburn-Smith Corp.—Booths 244-245. Centrifugal pump primer. Multi duct strainer.
Representative: I. H. Kaufman.

Boig & Hill—Booth 10. Curtis steam specialties.
Representatives: William T. Hill, Joseph Meyer and I. M. Masoff.

Bolinders Co., Inc.—Booth 481. Oil engine for generating sets and centrifugal pumps.
Representatives: K. H. Nilsson, Severin Clausen, E. J. Luster and Ruben Bengston.

Boston Gear Works Sales Co.—Booths 340-342. Speed reduction unit. Silent chain drives.
Representatives: H. H. Kerr, H. C. Woodsum, M. T. Schumb and H. Muller.

Botfield Refractories—Booth 567. Adamant high-temperature cement for furnaces.
Representatives: L. B. Botfield, Axel H. Engstrom, C. C. Phillips, W. B. Smith, A. J. Wittwer and J. J. Sweeney.

S. F. Bowser & Co.—Booth 424.
Representative: C. H. Bromley.

Bradley Washfountain Co.—Booth 247. Wash room equipment.
Representative: A. C. Cooper.

The Bristol Co.—Booth 12. Gages, thermometers, pyrometers, level indicators.
Representative: L. G. Bean.

Brown Hoisting Machinery Co.—Booth 450. Coal handling systems.

Brown Instrument Co.—Booth 88. CO_2 meter, thermometers, gages and pyrometers.
Representatives: J. P. Goheen, Secy., G. W. Keller, J. D. Andrews, George Goodman, R. F. Roberts, K. R. Knoblauch, George Beck, L. M. Morley and R. B. McCafferty.

Budd Grate Co.—Booth 290. Stoker and combustion arch system.
Representatives: H. Budd and Mr. McGinley.

Buffalo Steam Pump Co.—Booth 73. Pumps, fans, air heater and air washing system.

Builders Iron Foundry — Booth 277. Venturi meters for liquids.
Representatives: A. E. Watjen, D. J. Purdie and A. A. Wood.

Bundy Steam Trap Co.—Booth 8. Separating, return and lifting traps.
Representatives: Everett M. Stevens and Wallace W. Booth.

Edwin Burhorn Co.—Booth A. Cooling tower system.
Representatives: J. B. Harry, Vice Pres., J. S. Arbuckle, H. A. Stover, C. Dahlquist, F. A. Kopp, C. A. Harry and Charles Ramm.

Andrew C. Campbell, Inc.—Booth 440. Metal cutting machines.
Representatives: Stuart Narramore and J. Johnson.

Carbondale Grate Bar Co.—Booth 448. Grate bars.

Carborundum Co.—Booth 22. Carbofrax refractories.
Representatives: C. E. Hawke, S. A. Tenno, J. A. King, A. A. Lees and R. A. Beverley.

Carling Turbine Blower Co.—Booth 17. Safety turbine. Supervane blower.
Representatives: Axel W. Carlson, Albert L. Carlson, Harry W. Gilson, C. R. Vincent and C. R. Vincent, Jr.

Carr Fastener Co.—Booth 285. Dot high-pressure lubricating system.
Representatives: P. K. Niven, C. Towner, A. W. Smith, A. H. Taylor, R. C. Smith and Fred Jones.

Carrick Engineering Co.—Booth 264. Furnace regulation system.
Representatives: G. S. Carrick, John H. Hillmeyer, E. P. Sanders, L. R. Merritt and R. B. Kleinert.

Carrier Engineering Corp.—Booth 34. Air conditioning equipment.
Representative: W. H. Carrier.

A. W. Cash Co.—Booths 28 and 276. Craig combustion control system, pressure regulation, relief valves, ammonia valves.
Representatives: C. W. Court and V. A. McKechnie.

W. D. Cashin Co.—Booth 568. Thermoflex valves and fittings.
Representatives: W. D. Cashin, M. P. Miller and W. B. Parsons.

Celite Products Co.—Booth 14. Insulating brick for high temperatures.
Representatives: A. W. Knight, H. B. Whitmore, E. S. Crosby, W. L. Souther, P. R. Deschere, E. F. Davis and L. E. Putnam.

Centrifix Corporation—Booths 564-565. Steam purifying system.

Chapman Valve Mfg. Co.—Booth 2. Fittings and valves of chrome nickel steel. Remote control valves.
Representatives: Frank C. Shannon and O. H. Maher.

Cleveland Worm & Gear Co.—Booth 92. Worm gear speed reducers.

Clipper Belt Lacer Co.—Booth 337. Belt lacers and hooks.
Representatives: William F. Kall and Edward R. Dawson.

Cochrane Corp.—Booth 67. Water meters, filters, flow meters, steam traps, steam separators.
Representatives: J. S. L. Wharton, Pres., W. S. Hallowell, Treas., J. C. Jones, Vice Pres., H. E. Sibson, A. B. Wallem, J. E. Harris, J. D. Yoder, P. S. Lyon, J. B. Fowler, C. W. Wharton, F. E. Idell, W. W. Montalvo, Jr., F. B. Sage and A. R. Foote.

Coen Co., Inc.—Booth 15B. Oil burning system.
Representative: F. S. Harper.

Coffin Valve Co., Inc.—Booth 482. Special valves.

Combustion Engineering Corp.—Booths 23-25. Lopulco pulverized system, Raymond mill, air heater, stokers.
Representatives: R. C. Beadle and Charles McDonough.

Combustion Publishing Corp.—Booth 53. Publication and books on combustion.
Representative: H. Stuart Acheson.

D. Connelly Boiler Co.—Booth 92. Water-tube boilers.
Representatives: Charles Lang, C. W. Bergen and E. C. Welch.

Connery & Co.—Booth 43. Damper. Expansion stiffener for breechings.
Representatives: C. B. Nicholson and Albert D. Stewart.

William B. Connor, Inc.—Booths 346-347. Ace steam trap.

Consolidated Safety Valve Co.—Booth 60. Safety valves, gages, injectors, engine indicators.
Representatives: N. Allerdice, W. A. Blackmore, W. P. Bradbury, J. Briscoe, H. D. Carlton, N. B. Carlton, J. N. Derby, H. Jude, A. G. Marshall, W. J. H. Miller, E. K. Morris, M. S. Palmer, P. H. Ryan and C. Stepan.

Consolidation Coal Co.—Booth 454.

Continental Valve & Equipment Co.—Booth 328. Forged steel fittings, reducing valves and pump governors.

Cooling Tower Co.—Booth 532. Cooling towers, spray nozzles, air washers and filters.
Representatives: L. A. Phillips, E. C. Sickles, J. H. Taylor and A. A. Morse.

Cork Foundation Co.—Booth 420. Absorbo foundation material for absorbing vibration.
Representatives: Dore Sunderland, Walter S. Timmins and Maurice Deutsch.

Chas. Cory & Son, Inc.—Booths 241-242. Valve control units and signal system.
Representatives: C. N. Wheeler, Pres., J. S. Jones, Vice Pres., Mr. Casson, Treas., L. E. Oneal, A. D. Blanchard, W. A. Thomas, S. M. Mead, G. M. Marr, J. Harper, Sr., E. A. Spokes, J. E. Carrington, F. E. Elznic, A. A. Kopp, M. I. Warshaw, Mr. Cook, Mr. Mains and Mr. Hale.

Crane Co.—Booth 52. Specially operated valves, remote control, valves and pipe joints for high pressure.
Representatives: M. W. Link, G. E. Barker, T. H. Ireland, W. E. Allen, A. M. Houser and M. Baxter, Jr.

Crane Packing Co.—Booth 209. John Crane metallic packing, for steam, air, oil and ammonia systems and condenser tubes.
Representatives: F. E. Payne, J. N. Walton and Colby W. Bryden.

Crankless Engine Co.—402-403.

Crosby Steam Gage & Valve Co.—Booths 302-303. Safety valves, Nickeloy, bronze and steel valves. Valve tester.
Representatives: George F. Jelker, Pres. and L. W. Lenderolph.

Cutler-Hammer Mfg. Co.—Booth 16. Dean control units for valves, dampers and sash.

Dampney Co. of America—Booth 248. Apexior protective coatings for metals.
Representatives: E. Fenton Gilbert, Pres., C. F. Moore, Vice-Pres., T. H. Burch, Jr., and P. L. Rhodes.

M. T. Davidson Co.—Booths 36-37. Simplex and centrifugal pumps.
Representatives: John Lowe, Vice-Pres., Harry A. Prindle, William E. Brennau and Thomas J. Rogers.

G. M. Davis Regulator Co.—Booth 494. Pressure regulators, special valves, steam traps.
Representatives: H. A. Freeman, G. C. Davis, C. B. Davis, E. A. Anderson and George C. Davis, Pres.

Dearborn Chemical Co.—Booth 13. Water treatment system.
Representatives: Grant W. Spear, Vice Pres., W. H. Kinney, T. H. Platt, J. E. Harris, G. W. Carr and William C. Egan.

Julian D'Este Co.—Booth 10. Curtis engineering specialties, domestic water regulator, traps.
Representatives: D. A. Herrick, Geo. Bezanson, W. T. Hill, Joseph Meyer and I. Nazoff.

De Laval Separator Co.—Booths 536-543. Oil purifiers.
Representatives: P. F. Miller, D. F. Miller, A. O. Hopper, C. B. Bower, W. D. Cleary, J. H. Lisle, R. L. Smith and M. A. Monroe.

De Laval Steam Turbine Co.—Booth 536. Turbines, speed reduction gears, centrifugal pumps.
Representatives: F. J. Arend, Pres., F. W. Kennedy, Vice-Pres., H. Y. Hayden, H. L. Watson, J. W. Hertzler, L. W. Frisbee, C. R. Waller, A. Peterson and J. S. Beck.

M. H. Detrick Co.—Booth 94. Suspended arch. Special side wall for furnaces.
Representatives: R. D. Toltz, Walter M. Ehrlich, William A. Vidro, Louis Ellman, Louis Hosbein, F. I. Sheahan and Frank Pollen.

Detroit Stoker Co.—Booths 204-206. Underfeed stoker.
Representatives: Charles A. Reigle, Robert June and R. L. Beers.

Detroit Twist Drill Co.—Booth 503.

Diamond Power Specialty Co.—Booth 16. Soot blowers and equipment.
Representatives: Willis P. Thomas, Sec'y, Ivan S. Forde, Lynn W. Nones, M. J. Miller, J. E. Heeter, E. L. Woodworth and Robert June.

Walter S. Dickson & Co.—Booth 232. Ventilating and heating specialties.
Representatives: E. P. Sanders and R. B. Kleinert.

Joseph Dixon Crucible Co.—Booth 215. Graphite, greases, paints.
Representatives: J. M. Willitts, M. C. MacNaughton, O. D. Shonnard, C. A. Williamson, J. W. Caldwell, M. A. Koerber and H. M. Ragan.

F. W. Dodge Corp.—Booth 27. Publication.

Donnelly Systems Co.—Booth 407. Steam distribution and control equipment.
Representatives: James A. Donnelly and Frank R. Campbell.

Drake Non-Clinkering Furnace Blk. Co.—Booth 41. Furnace linings and bridge walls.

Durabla Manufacturing Co.—Booths 500-501. Packings, gage glasses, valve discs, metal pump valves.
Representatives: W. R. LeFevre, Mr. Starks, Mr. Marriott, Mr. Wilson, Mr. Von Kokeritz and Mr. Hill.

Eastern Steam Specialty Co.—Booth 12A. Steam traps and pumps.

Edge Moor Iron Co.—Booths 288-289. Single-pass water-tube boiler.
Representatives: William Bradford, G. C. Vennum, Walter Greacen, S. G. Bradford, J. F. Glenn, H. M. Lodge, W. L. Ford, H. C. Evans, W. G. Crichton and A. L. Tyre, Jr.

Edward Valve & Mfg. Co.—Booth 30. Steel and monel valves for high pressures.
Representatives: W. W. Crawford, Pres., F. H. Dunbar, J. L. Goodman, A. L. Lane and J. E. McDonald.

Elliott Co.—Booths 271-272-273-274. Kerr steam turbines, boiler tube cleaners, deaerators, ejectors.
Representatives: H. A. Pastre, W. E. Widau, C. W. Moore, C. L. Brown, H. L. Freas, C. S. Roosa, R. E. Roche, P. D. Rech, C. Schmidt, R. N. Tilley and H. D. Storer.

Lewis M. Ellison—Booth 44B. Draft gages. CO_2 gas analyzer.
Representatives: Lewis M. Ellison and Henning L. Hultman.

Chas. Engelhard, Inc.—Booth 417. Electrical meters for temperature and CO_2 measurement.
Representatives: Henry De Gallaix, J. H. Oetjen, J. H. Allison and R. W. Newcomb.

The Engineer Co.—Booth 18. Turner baffle walls, oil burners, combustion control regulators.
Representatives: K. L. Martin, Pres., A. W. Patterson, Vice Pres., Mr. Hampson, Mr. Holden, Mr. Parker and Mr. Streisel.

Engineering Magazine Co.—Booth 314. Publications.

The Engineers Book Shop—Booth 28A. Engineering books.

Erie City Iron Works—Booths 217-218. Coal pulverizing and feeding system. Water-tube boiler.
Representatives: J. Klien, W. C. Heckeroth and Albert W. Dowling, Jr.

Erie Malleable Iron Co. (Kondu Div.)—Booth 461.

Ernst & Co.—Booth 76. Inclined water gage.

Everlasting Valve Co.—Booths 100-101. Corrosion resisting valves, blowoff valves.
Representatives: John H. Allen, Pres., Wylie G. Wilson, E. N. Corning, S. E. Carman and G. M. Elton, Jr.

Ex-Cell-O Tool & Mfg. Co.—Booth 442. XLO bushings.

Goodman S. Fabian—Booth 570.

Fafnir Bearing Co.—Booth 246. Ball bearings for shafting and machinery.
Representatives: R. N. Hemenway, D. J. Gilbert, T. F. Reilly, George Barenborg, C. F. Stanley and H. Reynolds.

Fairbanks Morse & Co.—Booths 326-327-330-331. Piston and centrifugal pumps, electric motors and Diesel engines.
Representatives: H. C. White, G. S. Thompson, Allen E. Ransom, A. H. Gade, J. B. Sconce, E. C. Dunstone, H. P. Miller and W. G. Hampson.

Falk Corp.—Booths 338-339. Geared speed reducers and flexible couplings.
Representative: M. P. Fillingham.

Falls Engine Works—Booth 17. Automatic engine stop.

Federal Gauge Co.—Booth 544. Indicating and recording gages, Mercoid switches for motor control.
Representatives: L. H. Van Ness, Pres., N. J. Allaben, Vice-Pres., J. W. Owens, Vice-Pres., I. E. McCabe and A. N. Schultz.

Fisher Governor Co.—Booth 35. Pump governors, reducing and regulating valves, floats and steam traps.
Representatives: J. H. Fisher and C. B. Peterson.

Flexible Steel Lacing Co.—Booth 315. Alligator belt lacing and Flexco lamp guards.
Representatives: C. L. Garesche and H. Irwin Rheinhorn.

Flexitallic Gasket Co.—Booth 408. Gaskets and gasket making.
Representatives: Frank Groves, C. K. McBride and Frank E. Ring.

Flynn & Emrich Co.—Booth 46. Huber coking stokers.
Representatives: Charles J. Huber, Roland H. Lamb, Daniel T. Dobyns and Carl Smerling.

Foote Bros. Gear & Machine Co.—Booth 556. Worm and spur gear speed reducers and industrial gears.
Representative: John R. Shays, Jr.

Foster Engineering Co.—Booth 84. Non-return and pressure regulating valves and flexible joints.
Representatives: Charles A. Ollson, Charles R. Emerson, George H. Bauer, George E. Breece and H. J. Fortier.

Foxboro Co., Inc.—Booth 62. Indicating and recording gages and thermometers, liquid level gage.
Representative: W. W. Patrick, Vice Pres.

Frederick Iron & Steel Co.—Booth 465. Centrifugal pumps, coal grader and flexible, rubber-bushed coupling.
Representative: J. J. Conway.

Fuller Engineering Co.—Booth 14A-14B.

Fuller-Lehigh Co.—Booths 14A-14B. Fuller-Kinyon system for pulverized fuel.
Representatives: A. E. Douglass, H. G. Barnhurst, F. A. Scheffler, H. B. Jones, W. H. Fitch, J. B. Gaffney, Ralph Galt, H. R. Collins and R. A. Hawk.

The Fulton Co.—Booths 252-253. Sylphon temperature and pressure regulators.
Representatives: A. W. Shepherd, A. W. King and F. C. Reeder.

Representatives: Alex. Girtanner, Pres., J. J. McNulta, Treas., Wm. C. Weiman, Geo. Moulton, D. A. Jenkins, L. F. Mahler, E. W. Weyrauch, J. C. Henry, C. E. Moore, Mr. Renault, Mr. Hays and Mr. Green.

Jas. T. Gordon Co.—Booth 92. Water and oil strainers, speed reducers, Nicholson steam specialties.
Representative: J. T. Gordon.

A. P. Green Fire Brick Co.—Booths 202-203. Mizzon high-temperature brick, flint clay and super-refractory brick.
Representative: George E. Ford.

Griscom-Russell Co.—Booth 49. Reilly evaporators, heaters, oil coolers, steam and air separators.
Representatives: Stanley Brown, R. L. Robinson and K. B. Millett.

H. & O. Chain Co.—Booth 10. Flexible, anti-friction coupling.
Representative: C. C. Swartz.

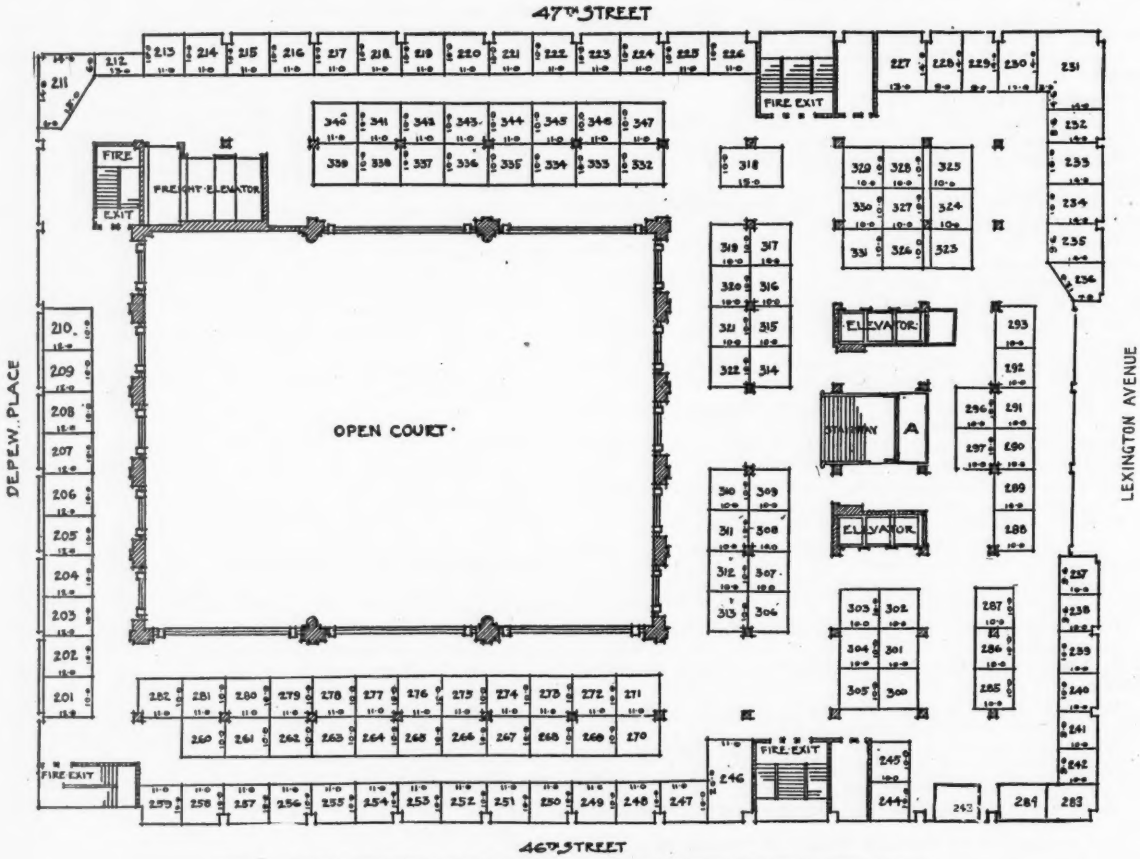


FIG. 2. ARRANGEMENT OF MEZZANINE FLOOR AT NEW YORK POWER SHOW

Furnace Engineering Co.—Booth 214. Simplex unit pulverizer.

G. & G. Atlas Systems, Inc.—Booth 15A. Pneumatic tube system.
Representatives: William H. Dinspel and Edmund Weigele.

Garlock Packing Co.—Booth 505. Packings and methods of manufacture.
Representatives: P. D. Miller, J. E. Hillerman, J. B. Reyalt, Cecil R. McAfee, Joseph Yamin, C. D. Castle, J. M. Drinkwater and M. P. Junkin.

General Electric Co.—Booths 4-5. Flow meters, brush-shifting motors and air cooler for turbo-generator ventilation.
Representative: C. T. McLoughlin.

General Refractories Co.—Booth 498. Refractories and fire clay in standard and special shapes.

Gillis & Goeghegan, Inc.—Booths 87-88. Electric and hand-operated hoist for ash removal.
Representatives: C. E. Prout, William D. Staples and E. D. Hooker.

Girtanner Engineering Corp.—Booth 258. Steam jet, vacuum and hydraulic ash conveying systems.

Hagan Corp.—Booth 21. Compensated draft system, steam purifier, water treatment.
Representatives: J. M. Hopwood, Pres., Albert C. Burke, Jr., F. H. Schubert, C. R. Matheny, L. Wharton Bickley, Joseph H. Spurgeon, H. W. Jarrett, R. L. Sheraton, Leopold Pistner, P. S. Miller, E. L. Folk, R. R. Donaldson, T. A. Peebles, D. J. Erikson, G. W. Smith and H. A. Jackson.

Hahn Engineering Co.—Booths 404-405. Conveyors, parts and bunkers for ash systems.
Representatives: Eugene Hahn, James W. Snowden and F. F. Harman.

Hand Stoker Corp.—Booth 46. Huber stokers.

Hanson & Yorke Co.—Booth 427.

Hanson Whitney & Co.—Booth 557. Drill presses and milling machines.

Hardinge Co.—Booth 329. Conical mills for pulverizing.

Jos. W. Hays Corp.—Booths 81-82. Draft gages, flue gas analyzer, CO_2 and draft recorder.
Representative: Paul B. Huyette.

Heine Boiler Co.—Booths 496-497. Water-tube boilers and construction.

Representatives: Edward R. Fish, Vice Pres. and R. D. Lillibridge.

Hendrick Mfg. Co.—Booth 471. Metal screens and stair treads.
Representatives: K. H. Colville, D. L. Bassett, B. G. Dann, A. B. Tappan, Mr. Tull, Mr. Homyer and Mr. Krulder.

E. Vernon Hill Co.—Booth 510. Pitot tube outfits.
Representative: Dr. E. Vernon Hill.

M. A. Hofft Co.—Booth 502. National suspended arch and hand-operated stoker.
Representatives: M. A. Hofft, Walter M. Squires and Wm. R. Van Nortwick.

Homestead Valve Mfg. Co.—Booth 428. Fluid action in valves, lubricated, quarter-turn valve, standard valves.
Representative: H. P. Ackerman.

Jas. Howden & Co. of America, Inc., (Air Preheater Corp.)—Booths 234-235. Ljungstrom air preheater, Howden compressors and forced draft.
Representatives: B. G. Brolinson, Pres., W. L. Batt and R. E. S. Geere.

Paul B. Huyette Co.—Booths 81-82. Hays CO_2 recorder, Ajacks damper regulator, PBH water gages and cocks.
Representatives: Paul B. Huyette, Walter C. Edge, Andrew F. Bittner, Henry R. Blessing, Justine J. McCarthy and Phillip Wood.

Hydraulic Press Mfg. Co.—Booth 551. Motor-operated automatic control valves, Forsteel fittings and valves.
Representative: H. E. Eddy.

Ilg Electric Ventilating Co.—Booth 533. Fans, motors and control for ventilation.

Illinois Engineering Co.—Booth 233. Reducing and back-pressure valves, steam traps, vapor heating system.
Representatives: James C. Matchett, Secy., A. L. Browne, Walter S. Dickson and Herbert Fox.

Imperial Coal Co.—Booth 410.

Industrial Management Group—Booth 314. Publications.
Representatives: Harvey Conover, Vice Pres. and Joseph Wehr.

Industrial Power—Booth 39. Publication.

Instant Water Heater Co.—Booth 12-A.

Insulating Products Corp.—Booth 437. Insulating materials.

International Filter Co.—Booth 221. Hot and cold process water softener, Zeolite softener and water filters.

International Nickel Co.—Booth 9. Monel metal and products made from it.
Representatives: J. F. McNamara, T. H. Dauchy, L. R. Larson, E. A. Turner and L. Miller Thym.

International Trade Press, Inc.—Booth 444. Publications.
Representatives: F. W. Kennedy and B. F. Damon.

Irving Iron Works Co.—Booths 438-439. Subway steel flooring and Safsteps for stairways.
Representatives: E. Brodhead, F. C. Yale, J. H. Miller, C. S. Line and William Noblett.

Jenkins Bros.—Booth 90. Standard and regrinding valves, packings, action of fluid as valves open and close.
Representatives: Fred G. Jolley, Charles L. Stallings, Charles Ohlsen and Charles Wick.

Johns-Manville, Inc.—Booths 508-509. Asbestos and allied products, pipe covering, building materials, packings and special forms.

W. A. Jones Foundry & Machinery Co.—Booth 549. Spur and worm gear speed reducers, friction clutch, compression and flexible coupling.
Representatives: R. B. Moir, O. W. Bochat and W. M. Sutton.

E. Keeler Co.—Booth 211. Glass model boilers to show actual boiler action.
Representatives: E. G. Wein, R. E. Foresman, A. C. Lippincott, H. L. Peel, G. L. Jones, G. W. Crawford, T. S. Widger and G. A. Barrows.

M. W. Kellogg Co.—Booth 72. Flange pipe joints and radial brick for chimneys.
Representative: T. F. Hoxey.

Key Boiler Equipment Co.—Booth 426. Hand hole caps, flange joints for high pressure.
Representatives: Fred Key, Vice Pres. and George W. Coleman.

Keystone Lubricating Co.—Booth 8A. Safety grease lubrication system, lubricators, greases.
Representatives: H. A. Busby, Pres., A. T. Lowry, F. D. Street, C. O. Norstrom and C. T. Moyer.

Keystone Refractories Co.—Booth 11. Key-Cel-Brix, Dura-stix binder and Steel Veneer for facing fire brick.
Representatives: F. W. Reisman, L. E. Turk, G. M. Sherman, B. G. Pitcher, P. Murphy and J. G. Collier.

Kieley & Mueller, Inc.—Booth 480. Steam specialties, traps, float and reducing valves, water columns.
Representative: C. H. Dutcher.

King Refractories Co.—Booth 95. Mono boiler baffling, Flame brand high temperature cements.
Representatives: S. C. Smith, Pres., John T. Bulkley, Vice Pres., T. J. Bulkley, F. B. Lythgoe and T. Amory Coffin.

Kingsford Foundry & Machine Works—Booth 425. Sectional water-tube boilers with steeply inclined tubes.

Kissick-Fenno Co.—Booth 19. Vulcan soot cleaners, Copes feed-water regulators.
Representatives: Joseph Kissick, Jr., George F. Fenno, Carl R. Fischer and W. J. McDonough.

John W. Kittredge—Booth 453. Two-speed chain hoist.
Representative: J. W. Kittredge.

Kitts Steam Specialty Co.—Booth 451.

Klingerit, Inc.—Booth 317. Piston valves, reflex water gage, asbestos valve disc.
Representatives: Herman Strahmann, C. H. Strahmann and H. C. Strahmann.

Geo. T. Ladd Co.—Booth 91. Details of water-tube boiler.
Representatives: Geo. T. Ladd, Pres., J. B. Crane, Vice Pres. and W. R. Holmes.

Lagonda Mfg. Co.—Booth 271. Tube cleaners.
Representatives: C. L. Brown, H. A. Pastre, G. J. Herbert and M. M. Sellers.

Lead Lined Iron Pipe Co.—Booth 86. Special pipe for corrosive liquids.
Representatives: J. D. Dwyer, D. F. Dwyer, T. E. Dwyer, D. H. Regan and F. H. Du Bois.

Libbey Glass Mfg. Co.—Booth 416. Gage glasses, sight glasses, for high pressures.
Representative: J. A. Carson.

Liberty Electric Corp.—Booth 435. Motor-operated valves.
Representative: Chas. A. Craig.

Liptak Fire-Brick Arch Co.—Booth 201. Suspension arches, air-cooled furnace walls.
Representatives: C. E. Sharp, R. M. Richardson and W. H. Boyd.

Locke Regulator Co.—Booth 307. Damper regulators.

Ludeman Bros., Inc.—Booth 516. Safety stops for engines, turbines and pressure lines.
Representative: Edwin H. Ludeman.

Lunkenheimer Co.—Booth 63. Cast steel valves for high pressure, monel metal valves, bronze and iron valves for all purposes.
Representatives: Frank P. Rhame and Charles W. Burrage.

McDonald & Co.—Booth 449.

McLeod & Henry Co.—Booth 13. Steel mixture for arches, high temperature cement, suspended arches, special tiles and baffles.
Representatives: Chas. N. Morgan, Pres., Andrew L. Keeler, Vice Pres., F. V. Tuthill, N. S. Burnham and T. J. Fitzpatrick.

W. B. McVicker Co.—Booth 323. Feed-water treatment.
Representatives: W. B. McVicker, Joseph F. Hammill and W. H. Creamer.

Manistee Iron Works—Booth 562. Roturbo pumps.

Manning Maxwell & Moore, Inc.—Booth 60A. Variable speed transmission, speed control.
Representatives: D. W. Clem, H. W. Randolph, C. B. Robinson and G. A. Ames.

Manufacturers Record—Booth 40. Publication.
Representatives: Kerfoot Marchant, E. H. Peed and Wm. H. Stone.

Marlin-Rockwell Corp.—Booths 336-343. Strom ball bearings and method of manufacture. Friction demonstration.
Representatives: M. E. Monk, H. N. Parsons, Miss Cora C. Smith, A. W. Wiese and A. G. Norris.

Marion Machine Foundry & Supply Co.—Booth 210. Soot blowers for water-tube and fire-tube boilers. Furnace observer.
Representative: W. H. Caldwell.

Mason Regulator Co.—Booths 223-224. Pressure regulators, pump governors, fan and stoker regulators, bronze, iron-body and cast-steel valves, damper regulator.
Representatives: F. A. Morrison, Secy., F. Kenneth Morrison and H. L. Peiler.

Merco-Nordstrom Valve Co., Inc.—Booth 267. Lubricated plug valves.
Representatives: Thomas Jabine, W. L. Travers and E. M. Wilson.

Merrick Scale Mfg. Co.—Booths 237-240. Conveyor weightometer for weighing material in transit.
Representative: F. P. Hambright.

L. R. Merritt Co.—Booths 31-32. Steam specialties.
Representative: L. R. Merritt.

Metalastic, Inc.—Booth 408. Plastic packing.

Metropolitan Brass Founders Ass'n.—Booth 477-478. Special castings.
Representatives: Thomas Harper, Pres., W. D. Goldsmith, Vice Pres., F. H. Landolt, Treas. and William E. Paulson, Secy.

Midwest Piping & Supply Co.—Booth 268. Pipe joints, welded headers, pipe bending.
Representatives: J. McC. Moffett and Paul F. Witte.

Moore Steam Turbine Corp.—Booth 433. Centrifugal pumps and steam turbines.
Representatives: M. D. Church, Pres., R. E. S. Geare, J. J. Mullan, E. H. Hendrickson and G. R. Probst.

Morse Chain Co.—Booths 262-263. Silent chain drives with rocker joint chain.
Representatives: V. D. Morse, W. W. Bertram, J. M. White, J. A. Meaney, A. B. Wray and C. L. Saunders

Morse Dry Dock & Repair Co.—Booths 300-301-304-305. Oil burning equipment and model of plant in operation.
Representatives: John T. Wiseman, J. D. Irish, George J. Foerst, J. George Kohl and Paul Nielson.

Moto Meter Co., Inc.—Booth 254. Industrial thermometers.
Representatives: J. C. Elverson, Alfred Weiss and H. C. Boynton.

Mueller Metals Co.—Booths 554-555.
Representatives: R. P. Windberg and A. P. Relken.

Murray Conduit Systems.—Booth 566.

Nash Engineering Co.—Booth 66. Jennings-Hytor vacuum and condensation pumps and sewage ejector.
Representatives: R. H. Carpenter, I. C. Jennings, H. M. Wylie, Russell Donnelly and C. B. Wright.

National Acme Co.—Booth 521. Screw machines.
Representatives: Charles Smart and H. T. Latts.

National Co., Inc.—Booth 76. Water column illuminator.

National Engineer—Booth 83. Publication.

National Lead Co.—Booth 517. Bolt anchors and babbit metals.
Representatives: R. E. Smith, G. Kohler, L. H. Coates and L. F. Johnston.

National Tube Co.—Booth 8B. Seamless tubing, boiler tubes, pipe and Vanstone joints.
Representative: W. L. Schaffer.

Naugatuck Mfg. Co.—Booth 447. Seamless copper ball floats.
Representative: C. P. Rodenbach, Secy.

Neemes Foundry, Inc.—Booth 93. Shaking and dumping grates.
Representatives: R. R. Rees, Vice Pres., E. C. Welsh and A. B. Taylor.

W. H. Nicholson & Co.—Booth 92. Steam traps, 4-way controlling valves, visible trap operation.
Representatives: J. B. Armstrong and R. A. Comstock.

Niles-Bement Pond Co.—Booths 528-529. Maag spur, helical and spiral gears.
Representatives: W. A. V. Thompson and Craig R. Smith.

Nitrose Co.—Booth 484. Acid resisting paint.

Norma-Hoffman Bearings Corp.—Booths 279-280. Ball, roller and thrust bearings.
Representatives: D. E. Batesole and F. W. Mesinger.

Northern Equipment Co.—Booth 19. Copes control valves, pump governors, valve indicators and feed-water regulators.
Representatives: E. W. Nick, Pres., V. V. Veenschoten, C. E. Wolff, Jr., E. L. Bowers, N. H. Brown, J. J. Kissick and W. J. McDonough.

Norton Co.—Booths 324-325. Alundum and Crystolon refractories in brick, tiles, baffles and cements.
Representatives: Harry B. Lindsay, C. W. Saxe, Fred E. Leiby and Robert Kirkpatrick.

S. Obermayer Co.—Booth 260. Refractory materials.
Representative: F. P. Bullion.

Tinius Olson Testing Machinery Co.—Booth 227. Testing machines for tensile, bending, compression, hardness and balance.
Representatives: Thorsten Y. Olsen, Vice Pres., Robert B. Lewis, Jacob Lundgren and Wm. J. Tretch.

Orange Bearing Co.—Booth 228. Roller bearings.
Representatives: C. W. Chisholm, Vice Pres., C. L. Ritchie, N. M. Leeds and E. V. Fischer.

Otis Elevator Co.—Booth 57. Heavy pipe fittings and steel castings.
Representatives: W. H. Daly, R. H. A. Carter and A. E. Handy.

Paulsen-Spence Co., Inc.—Booth 28. Traps, combustion control and water softening.

Peabody Engineering Corp.—Booth 47. Oil burning equipment.
Representatives: Ernest H. Peabody, Pres., and W. A. P. Penninger.

Peerless Machine Co.—Booth 401.

Pennsylvania Crusher Co.—Booths 286-287. Bradford coal breaker and Armorframe crusher.
Representative: Stanley D. Hartshorn.

Perfection Grate & Supply Co.—Booth 258. Hand stoker.

Permutit Co.—Booth 3. Zeolite water-softening system model, Ranarex combustion indicator.
Representatives: A. T. Smith, R. W. Epple, A. F. McConnell, J. S. Shedden, D. G. Saunders, F. D. West, M. F. Corin, D. J. Hess, H. L. Tiger, E. Pick and F. D. Harger.

Philadelphia Gear Works—Booth 10. Industrial gears, Fabroil pinions, Diamond sprocket chains.

Pitts & Kitts Mfg. & Supply Co.—Booth 451.

Pittsburgh Testing Laboratory—Booth 91. Demonstration of tests of materials.
Representatives: James Milliken, Pres., Frederick W. Green, Vice Pres., Harold W. Bates, Mercer B. Mayfield and J. W. Reifsnyder.

Pittsburgh Valve Foundry & Construction Co.—Booth 4. High-pressure piping and valves.
Representatives: George Stuart, J. R. Tanner, C. A. Anderson and G. P. Anderson.

Plibrico Jointless Fire Brick Co.—Booth 93. Model of furnace showing monolithic lining.
Representatives: I. S. Pieters, C. A. Werner, William Long and W. C. Herlihy.

William Powell Co.—Booth 495. White Star and Model Star regrinding valves in iron, brass, steel and monel metal.
Representatives: James Coombe and Charles Kammeron.

Power—Booth 42. Publication and books.

Power Plant Engineering—Booth 98. Publication.
Representatives: John A. Kershaw, George D. Lounsbery, Arthur L. Rice, Ralph E. Turner and Chester R. Earle.

Power Specialty Co.—Booth 20—Radiant type superheater, Foster connection superheater and Foster economizer.
Representatives: W. F. Keenan and A. Bradley.

Pratt & Cady Co.—Booth 48. Bronze and iron-body valves, and steel motor-operated valve.
Representatives:—R. T. Hatch, J. P. Ferguson, W. E. Foster, E. C. Magens, William Wagner, W. N. Case, H. H. Freund, Jr., and W. D. Cashin.

Pratt & Whitney Co.—Booths 526-527. Lathes and shapers in operation
Representatives: E. C. Schultz, A. H. S. D'Arcambal, Ben Sloan, G. W. McIntyre, R. C. Renno, E. A. Stiguel and E. J. Sullivan.

Preferred Utilities Co.—Booths 219-220. Ray rotary oil burners.
Representatives: S. D. Rickard, G. W. Bohn, J. S. Spalding, Arthur Roberts, Frank Glanz, Dwight Marfield, E. P. Lipsett and George Lovell.

Production Machine Co.—Booth 452.

Public Service Production Co.—Booths 462-463.

Pyramid Iron Products Co.—Booth 306. Pyramid grates.
Representatives: J. M. Dunphy, W. H. Cline and A. W. Foster.

Queen's Run Refractories Co., Inc.—Booth 569. Q. R. Glass brand fire brick.
Representatives: George H. Diack, Charles A. Sleicher, H. S. Sleicher, J. F. Marshall, L. C. Andrews, Allan A. MacLeod, C. A. Underwood, Frank Ruehe and Rosser Thomas.

Quigley Furnace Specialties Co.—Booth 89. Hytempite for furnace repairs, Ganisand for lining, insulating brick, acid-proof cement and triple A solutions for protecting iron and steel from rust, and concrete and brick from weather.
Representatives: W. S. Quigley, Pres., J. H. McPadden, W. H. Gaylord, Jr., A. A. Hutchinson, M. F. King, D. F. McMahon, F. J. Spillane, C. C. Gantzmen, H. M. Miller, H. M. Thompson and T. W. Hind.

Racine Tool & Machine Co.—Booth 3. High-speed metal cutting machinery.
Representatives: M. E. Erskine, Pres., and S. P. Schafer.

Ramsey Chain Company, Inc.—Booths 292-293. Silent chain drives with roller bearing.
Representatives: J. H. Ramsey, Vice Pres., D. I. Wheeler and F. G. Anderson.

Raymond Bros. Impact Pulverizer Co.—Booth 24. Pulverizing machinery.

Reading Steel Casting Co.—Booth 48. Reading and Pratt & Cady valves, motor-operated and for high pressure.
Representatives: R. T. Hatch, J. P. Ferguson, W. E. Foster, E. C. Magens, Wm. Wagner, W. N. Case, J. F. Smith, W. D. Cashin, W. E. Brown, H. A. Boynton, H. H. Freund, Jr., and C. C. Kissick.

Roberts Steam Specialty Co.—Booth 548. Water-gage light, water columns, floats, flue cleaner and weighted gage cocks.
Representative: G. W. Osborn.

John P. Robinson.—Booth 278. Gaskets.

Rollway Bearing Co.—Booth 409. Special bearings.

Roto Company—Booth 11-A. Cleaners for boiler tubes, economizers, condensers, evaporators, hand hole seats and caps.
Representatives: W. R. Danley, Pres.; W. M. Kelley and J. V. Doherty.

Ruggles-Coles Engineering Co.—Booth 329. Coal drying equipment.

Ruggles-Klingemann Mfg. Co.—Booths 559-560. Traps, pump governors, fan-engine and damper regulator, motor-operated valves, pressure regulators.

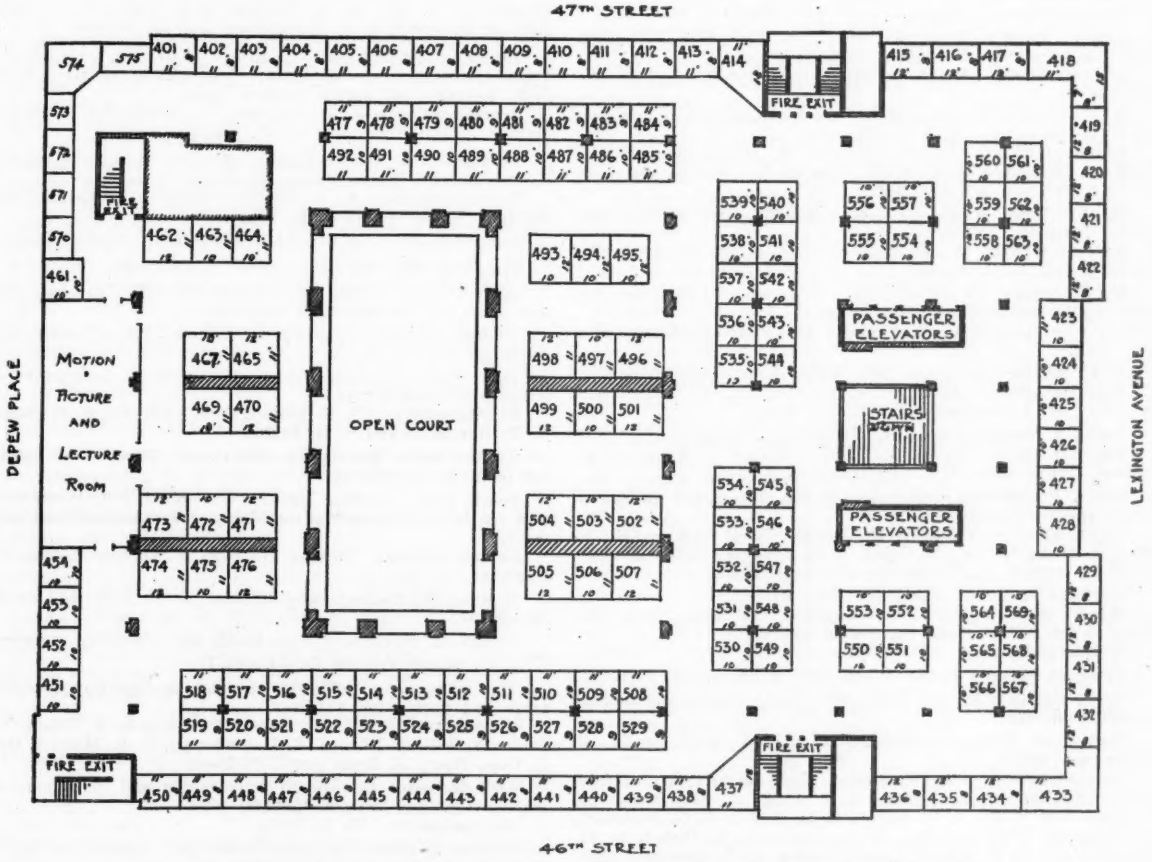


FIG. 3. THIRD FLOOR AND BOOTH POSITIONS FOR THE NEW YORK POWER SHOW

Reed Air Filter Co.—Booth 316. All-metal air filters.

Reeves Pulley Co.—Booth 60-A. Variable speed transmission.
Representatives: R. F. Reeves, Secy., and C. L. Irwin.

Reliance Gauge Column Co.—Booth 81. Safety water column with nickel alloy seats, discs and seamless floats for high pressures.
Representatives: C. C. Cleland and J. R. Brown.

Ren Mfg. Co.—Booth 415. Ren-Locks for light bulbs.
Representatives: R. E. Naumberg, Pres., and J. B. Paradise.

Republic Flow Meters Co.—Booth 6. Meters for steam flow, water, coal, air, CO_2 recorders, draft indicators, liquid level gage.
Representatives: J. D. Cunningham, Pres.; J. M. Spitzglass, Vice-Pres.; Albert Spitzglass, J. A. Morehouse, Geo. S. Hendrickson, R. L. Morse, H. C. Horton, Frank Hall, S. A. Reinhard, J. S. Hogg, G. V. Nightingale and George D. Conlee.

Richardson Scale Co.—Booths 283-284. Automatic coal scales.
Representatives: H. E. Godfrey, Secy.-Treas., and C. R. Clark.

Riley Stoker Corp.—Booth 79. Riley, Murphy and Jones stokers. Riley atritor for pulverized fuel plants.
Representatives: William Pestell, L. E. Griffith, W. T. Jordan, W. L. Schultz and O. C. Sheldon.

Representatives: Charles B. Klingemann, James L. Kimball and F. Nathaniel Currier.

Ruths Accumulator Corp., Ltd.—Booth 491. Ruths steam storage system and control valves.
Representatives: F. A. Wettstein, G. E. Lofgren and E. V. Ohara.

S-C Regulator Mfg. Co.—Booth 318. Standard and high pressure feed-water regulators, and S-C water control for boiler room equipment.
Representatives: J. M. Barrett, Secy., and H. S. Fraser.

S K F Industries, Inc.—Booths 332-333. Ball bearings for all industrial work.
Representatives: D. W. McAllen, R. H. DeMott, H. H. Yeager, A. Veith, J. D. Williamson, C. A. Decker and R. C. Byler.

Sarco Co., Inc.—Booth 33. Thermostatic control, traps, steam heating appliances.
Representatives: E. J. Ritchie, R. W. Cumming and J. L. Bruns.

Scandia Mfg. Co.—Booth 432.

Schutte & Koerting Co.—Booths 545-546. Special gate valves, spray cooling system, oil cooler with Radiafin tubes.

Representatives: H. W. Philbrook, C. T. Keet, J. J. Gessleman, O. A. Lindeman, R. E. Hellmer, S. G. Ketterer and H. C. Woodward.

Scovill Mfg. Co.—Booth 69. Brass, bronze and nickel silver rods, tubing and sheets. Admiralty condenser tubes.

Representatives: Philip Davidson, Charles A. Gleason, George B. Kerr, Jr., and L. L. Williams.

Seminole Chemical Co.—Booths 256-257. Boiler cleaning system.

Representatives: Leo Sherman, Thomas L. McKenna, R. F. Carbon and H. W. Hall.

Sharples Specialty Co.—Booth 26. Centrifugal purifiers for oil.

Benjamin F. Shaw Co.—Booth 473.

Sherwood Mfg. Co.—Booth 245. Injectors and lubricating systems.

Simplex Oil Heating Co.—Booth 492. Oil burning system.

Representatives: Edgar L. Nock and Arthur J. Maxfield.

Simplex Valve & Meter Co.—Booth 76. Indicating, recording and totaling meters of venturi type.

Representatives: M. M. Bordan, A. W. Sweeten and W. K. Sowdon.

D. H. Skeen & Co.—Booth C. Mercon regulators, governors, valve control for pumps and boiler feed.

Representatives: Geo. W. Stetson, A. MacLachlan, W. E. Groff, M. N. Dannenbaum, W. K. Sowdon, Mr. Neville, Mr. Kilner, Mr. Sherman and Mr. Herr.

Skinner Bros. Mfg. Co.—Booths 321-322. Air heaters and special industrial ovens.

Representatives: E. F. Tilley, Jr., F. A. S. Wood, A. W. Smith and E. V. D. Wallace.

M. B. Skinner Co.—Booth 431. Pipe and joint clamps for mending leaks, valve reseating tools.

Representatives: M. B. Skinner, Pres., Mr. McMurray and Mr. Ford.

F. L. Smidth Co.—Booth 281. Lenix, short-center drive.

Representatives: A. B. Zahn, V. Sahmel, R. Salmonsen, B. Oberg, O. A. Andreasen and B. F. Clark.

Smith & Serrell—Booth 85. Flanges and couplings.

Representatives: Robert A. Smith, Horace F. Field, G. A. Dalton, Harold Case, J. J. Serrell and E. B. Gray.

Smoot Engineering Corp.—Booths 418-419. Smoot system of boiler operation control.

Representatives: Charles H. Smoot, Cyril J. King, R. A. Wright, C. L. Joly, J. L. Wood, J. F. Shadgen, H. R. Kessler, S. B. DeCamp, E. W. Trowbridge and F. H. Plum.

Southern Engineer—Booth 10. Publication.

W. K. Sowdon—Booth 76. Simplex, Williams Gauge Co., Ernst & Co. and National Co. Steam specialties.

Representative: W. K. Sowdon.

Speednut Wrench Corp.—Booth 443. Rapid action wrenches.

Spray Engineering Co.—Booth 469. Spray nozzles and cooling system equipment.

Springfield Boiler Co.—Booths 31-32. Working model of water-tube boiler.

Representatives: Geo. W. Stetson, L. R. Merritt, R. B. Klienert, O. S. Carter, John Fenson, R. M. Rush, H. Clay Moore, A. J. Abels, Lon Sloan, A. W. Smith, L. H. Keller, A. G. Miller, C. C. Ferguson, W. P. Nevins, O. J. Gasche, R. J. Disher, L. H. Chamberlain, C. B. Abbott, Owsley Brown, J. S. Hammerslough, H. J. E. Banck, W. H. Jacobi and Robert Lacy.

Stack Heater Co.—Booth 312.

Standard Steel & Bearings, Inc.—Booth 343. Molybdenum steel balls, ball bearings and methods of gaging.

Representatives: Robert L. Dabney, W. F. Jones and H. A. Johnston.

Standard Water System Co.—Booth 28. Feed-water treatment.

Steacey-Schmidt Mfg. Co.—Booth 329. Steam specialties.

Sterling Engine Co.—Booth 518. 6-cylinder gasoline engine.

Representatives: M. E. Mutchler and C. A. Criqui, Jr.

Sterling Engineering & Mfg. Co.—Booth 28. Sterling system of boiler feeding by lifting and return traps.

Representatives: Chas. G. Stebbins, E. Sherman Hall, Paulsen Spence and Herbert W. Brandt.

Stewart-Sayers Co., Inc.—Booth 26. Oil purifying apparatus.

Strom Ball Bearing Mfg. Co.—Booth 534. Ball bearings.

Representatives: A. W. Wiese, A. G. Norris and Miss Cora E. Smith.

Strong-Scott Mfg. Co.—Booth 407.

Sturtevant, B. F. Co.—Booths 411-412-413-414. Fans, blowers, turbines, motors, stokers, economizers, air preheaters.

Representatives: G. C. Derry, J. A. Flemings, F. R. Ellis and J. F. Daggett.

Sumet Corp.—Booth 427.

Superheater Co.—Booth 56. Elesco superheater units with forged return bends and ball joints for 385 lb. pressure.

Representatives: R. M. Gates, D. S. Carter, L. H. A. Weaver, B. N. Broido, R. L. Ehmann and A. H. Chas. Dally.

Swartwout Co.—Booths 229-230. Low-pressure trap, separators, exhaust heads, ventilators and feed-water heaters.

Representatives: George H. Thomson, D. K. Swartwout, Jr., P. R. Jones, J. W. Johnson and N. W. Harkness.

Sweet & Doyle Fdry. & Mach. Co.—Booth 575.

Sweets Catalogue Service—Booth 27.

Representatives: C. B. Wagner, P. Wolff and H. Barnes.

C. J. Tagliabue Mfg. Co.—Booth 59. Mercury and spring recording thermometers, temperature and pressure control, viscosimeter.

Representatives: L. C. Irwin, Vice Pres., H. D. Cooke, V. Wichum, D. C. Day, R. M. Wilhelm, B. O. Pallin, W. C. Begeebing, A. F. Rucks, L. M. Hackenberg and M. Malone.

Taylor Instrument Cos.—Booth 507. Recording and indicating Tycos thermometers, temperature control, pyrometers, barometers, mercury and spring vacuum gages.

Representatives: J. W. Schwarz, F. Ernest Ely, Walker M. Maurer, J. P. Gilmore and H. W. Kugler.

Techno-Service Corp.—Booths 265-266. Borsig valves with electric control, Kobra pump for sludge or ashes.

Representatives: F. K. Loeffler, Pres., E. Doderer, Treas., William H. Baker and J. K. Wood.

Templeton, Kenly & Co., Ltd.—Booth 504. Simplex jacks.

Templeton Mfg. Co.—Booth 28. Steam traps.

Terry Steam Turbine Co.—Booths 421-422. Turbines, reduction gears and flexible shaft couplings.

Thomas Flexible Coupling Co.—Booth 222. Flexible shaft couplings.

Tide Water Oil Sales Corp.—Booth 95-A. Lubricants and methods of manufacture.

Representatives: A. R. Nelson, John J. Reddy, P. F. Cassidy, A. R. Burchsted and S. D. Brant.

Timken Roller Bearing Co.—Booth 467. Taper roller bearings for industrial machinery.

Toledo Pipe Threading Machine Co.—Booth 499. Power-driven pipe cutting and threading machinery, also hand-operated equipment.

Representatives: Clarence H. Popp, F. D. Stuart and A. T. Papineau.

Topping Brothers—Booths 503-504. Twist drills and welding equipment.

Torchweld Equipment Co.—Booth 503. Welding equipment.

Tracy Steam Purifier Co.—Booth 17.

The Trane Co.—Booth 472. Special vacuum pump, radiator traps and packingless valves.

Representatives: R. N. Trane, Pres., James A. Trane, Vice-Pres., M. William Ehrlich, R. H. Anderegg, F. R. Menzies, Grant E. Cole, Harry J. Ryan and I. S. Dane.

Trill Indicator Co.—Booth 429. Single and continuous card engine stops and turbine blowers.

Representative: W. L. Trill.

Triplex Machine Tool Co.—Booth 441. Lathes, milling machines, grinders and nibbling machines.

Representatives: John Cetrule, Nicholas Cetrule, J. H. Wilhelm, L. E. Larsen and P. E. Seibel.

Uehling Instrument Co.—Booth 45. Waste meter for chimney gases, combined barometer and vacuum gage.

Representatives: F. F. Uehling, C. C. Phelps, C. J. Schmid, A. C. Schmid, P. C. Riccobene and F. D. Bogia.

Union Iron Works—Booth 519. Union water-tube and universal boilers.

Representative: Joseph Lappin.

Vastine Sales Corp.—Booth 520. Furnace fire observer.

Representatives: R. P. Vastine, E. C. Brisbane, Vice Pres., J. S. Merritt, Sr., J. S. Merritt, Jr., Mr. Ames, Mr. Lappin, Mr. Toussaint and Mr. Benjamin.

Vincent-Gilson Engineering Co., Inc.—Booth 17. Soot blowers, engine stops and turbine blowers.

Representatives: C. R. Vincent, Harry W. Gilson and C. R. Vincent, Jr.

Henry Vogt Machine Co.—Booths 269-270. Drop-forged steel valves and fittings for extreme high pressures.

Representatives: Walter S. Cannon, Jr., and Paul F. Witte.

Vulcan Radiator Co.—Booth 406.

Vulcan Soot Cleaner Co.—Booth 19. Soot cleaners.

Representatives: Frederick W. Linaker, Vice-Pres., Mr. Kissick and Mr. Fenno.

Wailes-Dove-Hermiston Corp.—Booths 261-262. Bunker lining systems, Bitumastic and Hermastic paints for preventing corrosion.

Waite, Davey & Co., Inc.—Booth 255. Suspended arches, air-cooled side walls, rear combustion arches.
Representatives: Frank H. Waite, Pres., G. W. Davey and K. H. Woolson.

Walsh & Weidner Boiler Co.—Booths 250-251. Forged steel sectional headers and other boiler details.
Representative: W. E. Weigel.

Walworth Co.—Booths 308-311-444. High-pressure fittings of Sigma steel, Walworth tools, Kewanee unions.
Representatives: John Olmstead, Fred Duemler, J. J. Harman, Harry Weber, T. Nickerson, Fred Churchill, L. F. Hamilton and Hugh Morehead.

Warren Steam Pump Co.—Booth 231. Reciprocating and centrifugal pumps. Hickman air separator.
Representatives: H. W. Hathaway, J. G. Rearick, J. B. Nibling, H. C. Tetter and Parkman A. Collins.

Watts Regulator Co.—Booth 309. Reducing valves, feed-water, damper and pressure regulators, pump governors.
Representatives: B. E. Horne and E. A. Briesemeister.

Wayne Tank & Pump Co.—Booth 99. Industrial water softener in working model.
Representatives: Eskel Nordell, C. F. Leland, W. H. Mason, W. M. Cleaver and R. Bellows.

Warren Webster and Co.—Booths 225-226. Working model modulation system of steam heating. Feed-water heaters.
Representatives: John A. Serrell.

Westinghouse Elec. & Mfg. Co.—Booths 487-488-489-490. Steam turbines, air ejectors, circuit breakers, micarta products.
Representatives: R. A. Neal, J. S. Gilmore and R. W. Cargo.

Weston Electrical Instrument Co.—Booth 506. Portable and switchboard electrical measuring apparatus.

Wheeler Condenser & Engineering Co.—Booth 64. Condensers, high-efficiency and 2-pass, air pump, cooling tower, film-type evaporator.

C. H. Wheeler Mfg. Co.—Booth 77. Vacuum pumps, Radojet air removal pump, Radojet augmenter, Froude dynamometer.
Representatives: G. L. Kothny, Charles Lang and J. Dobson.

Whitney Mfg. Co.—Booth 557. Silent and roller chain drive.
Representatives: C. E. Wertman, D. I. Wheeler, A. C. Woodbury and R. J. Howison.

Wickes Boiler Co.—Booth 479. Lantern slide display of boilers, details and installation.
Representative: C. L. Smith.

Williams Gauge Co.—Booth 291. Stets system of boiler feed control. Water columns, gauge cocks, pump governors.
Representatives: R. M. Williams, A. Pohlman and W. K. Sowdon.

D. T. Williams Valve Co.—Booth 493. Reverso and Iroverso valves, oil and grease cups, boiler fittings, steam traps.
Representatives: H. J. Ernst, Treas., and Thomas F. Byrne.

Wilson Welder & Metals Co.—Booths 485-486. Welding machine.
Representative: W. M. Bastable.

L. J. Wing Mfg. Co.—Booth 61. Turbine blowers, motor-driven blower, Featherweight heating units, Scruplex exhausters and propeller fans.
Representatives: Alfred E. Seelig, Pres., Harry S. Wheeler, Vice Pres., Victor H. Carples, Secy. and Treas., and L. E. Seelig.

Wisconsin Electric Co.—Booth 442. Dumore motor-driven grinders. Dumore small motors.

T. B. Wood's Sons Co.—Booth 474. Power transmission equipment.
Representatives: C. O. Wood, W. H. Fisher, T. B. Wood, G. H. Wood, C. E. Bailey and G. R. Washinger.

Worthington Pump & Machinery Corp.—Booths 511-513. Diesel engine, O S centrifugal pump, Deane triplex power pump, water and oil meters.
Representatives: C. W. Rice, H. L. Conklin, E. W. Hammond, K. F. Bernard, J. H. Messerly, C. K. Hood, R. H. Lloyd and F. W. Hankins.

Wright-Austin Co.—Booth 236. Heavy water gauge, weighted gauge cock, Brownie low water signal for small boilers.
Representatives: C. Burt Walter, Vice Pres., and H. Dusenbery.

X Laboratories—Booth 259. X liquid for boiler leaks.
Representatives: E. R. Tolfree, Pres., Philip M. Southworth and Walter G. Larkin.

Yarnall-Waring Co.—Booths 7-A and 7-B. Yarway-Lee V-notch meter, hollow piston blowoff valve, spray nozzles.
Representatives: B. G. Waring and D. R. Yarnall.

BOOTHS AND EXHIBITS TO BE FOUND IN EACH

A—Edwin Burhorn Co., New York, N. Y.
C—D. H. Skeen and Co., Chicago, Ill.
2—Chapman Valve Mfg. Co., Indian Orchard, Mass.
3—The Permutit Co., New York, N. Y.
3—Racine Tool & Machine Co., Racine, Wis.
4—Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, Pa.
4-5—General Electric Co., Schenectady, N. Y.
6—Republic Flow Meters Co., Chicago, Ill.
7A-7B—Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.
8—Bundy Steam Trap Co., Nashua, N. H.
8A—Keystone Lubricating Co., Philadelphia, Pa.
8B—National Tube Co., Pittsburgh, Pa.
9—The International Nickel Co., New York, N. Y.
10—Boig & Hill Co., New York, N. Y.
10—Julian d'Este Co., Boston, Mass.
10—The H & O Chain Co., So. Norwalk, Conn.
10—Philadelphia Gear Works, Philadelphia, Pa.
10—Southern Engineer, Atlanta, Ga.
11—Keystone Refractories, New York, N. Y.
11A—The Roto Co., Hartford, Conn.
12—The Bristol Co., Waterbury, Conn.
12A—Eastern Steam Specialty Co., New York, N. Y.
12A—Instant Water Heater Co., No. Manchester, Ind.
13—Dearborn Chemical Co., Chicago, Ill.
13—McLeod & Henry Co., Troy, N. Y.
14—Celite Products Co., Los Angeles, Calif.
14A-14B—Fuller-Lehigh Co., Fullerton, Pa.
—Fuller Engineering Co., Allentown, Pa.
15A—G & G Atlas Systems, Inc., New York, N. Y.
15B—Coen Co., Inc., San Francisco, Calif.
16—Cutler-Hammer Mfg. Co., Milwaukee, Wis.
16—The Diamond Power Specialty Co., Detroit, Mich.
17—Andrews-Bradshaw Co., Pittsburgh, Pa.
17—Carling Turbine Blower Co., Worcester, Mass.
17—Falls Engine Works, Sheboygan, Wis.
17—Tracy Steam Purifier Co., Pittsburgh, Pa.
17—Vincent-Gilson Engineering Co., Inc., New York, N. Y.
18—The Engineer Co., New York, N. Y.
19—Kissick-Fenno Co., Philadelphia, Pa.
19—Northern Equipment Co., Erie, Pa.
19—Vulcan Soot Cleaner Co., Du Bois, Pa.
20—Power Specialty Co., New York, N. Y.
21—Hagan Corporation, Pittsburgh, Pa.
22—The Carborundum Co., Perth Amboy, N. J.
23—Combustion Engineering Corp., New York, N. Y.
24—Raymond Bros. Impact Pulverizer Co., Chicago, Ill.
25—Combustion Engineering Corp., New York, N. Y.
26—The Sharples Specialty Co., Philadelphia, Pa.
26—Stewart-Sayres Co., New York, N. Y.
27—F. W. Dodge Corp., New York, N. Y.
27—Sweets Catalogue Service, New York, N. Y.
28—A. W. Cash Co., Decatur, Ill.
28—Paulsen-Spence & Co., New York, N. Y.
28—Standard Water System Co., Hampton, N. J.
28—Sterling Engineering & Mfg. Corp., Hyde Park, Mass.
28—Templeton Mfg. Co., Boston, Mass.
28A—The Engineers Book Shop, New York, N. Y.
30—The Edward Valve & Mfg. Co., East Chicago, Ind.
31-32—L. R. Merritt Co., New York, N. Y.
31-32—Springfield Boiler Co., Springfield, Ill.
33—Sarco Co., Inc., New York, N. Y.
34—Carrier Engineering Corp., Newark, N. J.
35—The Fisher Governor Co., Marshalltown, Iowa.
36-37—M. T. Davidson Co., New York, N. Y.
38—The Ashton Valve Co., Boston, Mass.
39—Industrial Power, Chicago, Ill.
40—Manufacturers Record, Baltimore, Md.
41—Drake Non-Clinkering Furnace Block Co., New York, N. Y.
41—Furnace Engineering Co., Inc., New York, N. Y.
42—Power, New York, N. Y.
43—Connery & Co., Philadelphia, Pa.
44A—Walworth Co., Boston, Mass.
44B—Lewis M. Ellison, Chicago, Ill.
45—Uehling Instrument Co., Patterson, N. J.
46—Flynn and Emrich Co., Baltimore, Md.
46—Hand Stoker Corp., New York, N. Y.
47—Peabody Engineering Co., New York, N. Y.
48—American Chain Co., Inc., Bridgeport, Conn.
48—Pratt & Cady Co., Bridgeport, Conn.
48—Reading Steel Casting Co., Bridgeport, Conn.
49—Griscom-Russell Co., New York, N. Y.
50-51—R. H. Beaumont Co., Philadelphia, Pa.
52—Crane Co., Chicago, Ill.
53—Combustion Publishing Co., New York, N. Y.
54—Bailey Meter Co., Cleveland, Ohio.
55—Bailey Meter Co., Cleveland, Ohio.
56—The Superheater Co., New York, N. Y.
57—Otis Elevator Co., New York, N. Y.

58—American Arch Co., Inc., New York, N. Y.
59—C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
60—The Consolidated Safety Valve Co., New York, N. Y.
60A—Manning, Maxwell & Moore, New York, N. Y.
60A—Reeves Pulley Co., Columbus, Ind.
61—L. J. Wing Mfg. Co., New York, N. Y.
62—The Foxboro Co., Inc., Foxboro, Mass.
63—The Lunkenheimer Co., Cincinnati, Ohio.
64—Wheeler Condenser & Engineering Co., Carteret, N. J.
65—American Brass Co., New York, N. Y.
65—Anaconda Copper Mining Co., New York, N. Y.
66—Nash Engineering Co., So. Norwalk, Conn.
67—Cochrane Corp., Philadelphia, Pa.
68—The Bigelow Co., New Haven, Conn.
69—Scoville Manufacturing Co., Waterbury, Conn.
70-71—Bethlehem Shipbuilding Corp., Ltd., Bethlehem, Pa.
72—M. W. Kellogg Co., New York, N. Y.
73—Buffalo Steam Pump Co. and Buffalo Forge Co., Buffalo, N. Y.
74—American Schaeffer & Budenberg Corp., Brooklyn, N. Y.
75—The Allen-Sherman-Hoff Co., Philadelphia, Pa.
76—Ernst & Co., Newark, N. J.
76—National Co., Inc., Boston, Mass.
76—Simplex Valve & Meter Co., Philadelphia, Pa.
76—W. K. Sowdon, New York, N. Y.
77—C. H. Wheeler Mfg. Co., Philadelphia, Pa.
78—Bernitz Furnace Appliance Co., Boston, Mass.
79—Riley Stoker Corp., Worcester, Mass.
80—American Society of Mechancial Engineers, New York, N. Y.
81—The Reliance Gauge Column Co., Cleveland, Ohio.
81-82—Jos. W. Hays Corp., Michigan City, Ind.
81-82—Paul B. Huyette Co., Philadelphia, Pa.
83—National Engineer, Chicago, Ill.
84—Foster Engineering Co., Newark, N. J.
85—Smith & Serrell, Newark, N. J.
86—Lead Lined Iron Pipe Co., Wakefield, Mass.
87-88—Gillis & Goegheghan, Inc., New York, N. Y.
88—Brown Instrument Co., Philadelphia, Pa.
89—Quigley Furnace Specialties Co., New York, N. Y.
90—Babbit Steam Specialty Co., New Bedford, Mass.
90—Jenkins Bros., New York, N. Y.
91—The George T. Ladd Co., Pittsburgh, Pa.
91—Pittsburgh Testing Laboratory, Pittsburgh, Pa.
92—Andale Engineering Co., Philadelphia, Pa.
92—Cleveland Worm & Gear Co., Cleveland, Ohio.
92—D. Connelly Boiler Co., Cleveland, Ohio.
92—James T. Gordon Co., New York, N. Y.
92—W. H. Nicholson & Co., Wilkes-Barre, Pa.
93—Neemes Foundry, Inc., Troy, N. Y.
93—Plibrico Jointless Firebrick Co., Chicago, Ill.
94—M. H. Detrick Co., New York, N. Y.
95—King Refractories Co., New York, N. Y.
95A—Tidewater Oil Sales Co., New York, N. Y.
98—Power Plant Engineering, Chicago, Ill.
99—Wayne Tank & Pump Co., Fort Wayne, Ind.
100-101—Everlasting Valve Co., Jersey City, N. J.
201—Liptak Fire-Brick Arch Co., Mexico, Mo.
202-203—A. P. Green Fire Brick Co., Mexico, Mo.
204-206—Detroit Stoker Co., Detroit, Mich.
207-208—American Car and Foundry Co., New York, N. Y.
209—Crane Packing Co., Chicago, Ill.
210—Marion Machine, Foundry and Supply Co., Marion, Ind.
211—E. Keeler Co., Williamsport, Pa.
212—Alsop Engineering Co., New York, N. Y.
213-214—Arca Regulators, Inc., New York, N. Y.
215—Joseph Dixon Crucible Co., Jersey City, N. J.
216—The Bayer Co., St. Louis, Mo.
217-218—Erie City Iron Works, Erie, Pa.
219-220—Preferred Utilities Co., New York, N. Y.
221—International Filter Co., Chicago, Ill.
222—Thomas Flexible Coupling Co., Warren, Pa.
223-224—Mason Regulator Co., Dorchester Center, Boston, Mass.
225-226—Warren Webster & Co., Camden, N. J.
227—Tinius Olsen Testing Mach. Co., Philadelphia, Pa.
228—Orange Bearing Co., Orange, N. J.
229-230—Swartwout Co., Cleveland, Ohio.
231—Warren Steam Pump Co., Warren, Mass.
232—Walter S. Dickson & Co., New York, N. Y.
233—Illinois Engineering Co., Chicago, Ill.
234-235—Air Preheater Corp., Wellsville, N. Y.
234-235—James Howden Co. of America, Inc., New York, N. Y.
236—Wright-Austin Co., Detroit, Mich.
237-240—Merrick Scale Mfg. Co., Passaic, N. J.
241-242—Chas. Cory & Son, Inc., New York, N. Y.
244—Automatic Primer Co., Chicago, Ill.
244-245—Blackburn-Smith Corp., New York, N. Y.
245—Sherwood Mfg. Co., Buffalo, N. Y.
246—Fafnir Bearing Co., New Britain, Conn.
247—Bradley Washfountain Co., Milwaukee, Wis.
248—The Dampney Co. of America, Boston, Mass.
249—The Ballwood Co., New York, N. Y.
250-251—Walsh & Weidner Boiler Co., Chattanooga, Tenn.
252-253—The Fulton Co., Knoxville, Tenn.
254—The Moto-Meter Co., Long Island City, N. Y.
255—Waite Davey & Co., Long Island City, N. Y.
256-257—Seminole Chemical Co., New York, N. Y.
258—Girtanner Engineering Corp., New York, N. Y.
258—Perfection Grate & Supply Co., Springfield, Mass.
259—X Laboratories, New York, N. Y.
260—S. Obermayer Co., Newark, N. J.
261-262—Wailes-Dove-Hermiston Corp., New York, N. Y.
262-263—Morse Chain Co., Ithaca, N. Y.
264—Carrick Engineering Co., Chicago, Ill.
265-266—Techno-Service Corp., New York, N. Y.
267—Merco-Nordstrom Valve Co., Inc., New York, N. Y.
268—Midwest Piping and Supply Co., St. Louis, Mo.
269-270—Henry Vogt Machine Co., Louisville, Ky.
271—Lagonda Mfg. Co., Springfield, Ohio.
271-274—Elliott Co., Jeannette, Pa.
275—Advance Engineering Co., New York, N. Y.
275—Armstrong Machine Works, Three Rivers, Mich.
276—A. W. Cash Co., Decatur, Ill.
277—Builders Iron Foundry, Providence, R. I.
278—John P. Robinson, New York, N. Y.
279-280—Norma-Hoffmann Bearings Corp., Stamford, Conn.
281—F. L. Smidth & Co., New York, N. Y.
283-284—Richardson Scale Co., Clifton, N. J.
285—Carr Fastener Co., Cambridge, Mass.
286-287—Pennsylvania Crusher Co., Philadelphia, Pa.
288-289—Edge Moor Iron Co., Edge Moor, Del.
290—Budd Grate Co., Philadelphia, Pa.
291—The Williams Gauge Co., Pittsburgh, Pa.
292-293—Ramsay Chain Co., Albany, N. Y.
296-297—American Blower Co., Detroit, Mich.
300-301—Morse Dry Dock & Repair Co., Brooklyn, N. Y.
302-303—Crosby Steam Gauge & Valve Co., Boston, Mass.
304-305—Morse Dry Dock & Repair Co., Brooklyn, N. Y.
306—Pyramid Iron Products Co., New York, N. Y.
307—Locke Regulator Co., Salem, Mass.
308—Walworth Co., Boston, Mass.
309—Watts Regulator Co., Lawrence, Mass.
311—Walworth Co., Boston, Mass.
312—Stack Heater Co., Boston, Mass.
313—Barnes & Jones, Boston, Mass.
314—Industrial Management Group, New York, N. Y.
314—Engineering Magazine Co., New York, N. Y.
315—Flexible Steel Lacing Co., Chicago, Ill.
316—Reed Air Filter Co., Louisville, Ky.
317—Klingerit, Inc., New York, N. Y.
318—The S-C Regulator Mfg. Co., Fostoria, Ohio.
319-320—Aero Pulverizer Co., New York, N. Y.
321-322—Skinner Bros. Mfg. Co., Inc., Elizabeth, N. J.
323—W. B. McVicker Co., Brooklyn, N. Y.
324-325—Norton Co., Worcester, Mass.
326-327—Fairbanks Morse & Co., Chicago, Ill.
328—Continental Valve & Equipment Co., Framingham, Mass.
329—Hardinge & Co., New York, N. Y.
329—Ruggles-Coles Engineering Co., New York, N. Y.
329—Steacy-Schmidt Co., York, Pa.
330-331—Fairbanks Morse & Co., Chicago, Ill.
332-333—S K F Industries, Inc., New York, N. Y.
334-335—Armstrong Cork & Insulation Co., Pittsburgh, Pa.
336—Marlin-Rockwell Corp., Chicago, Ill.
337—Clipper Belt Lacer Co., Grand Rapids, Mich.
338-339—The Falk Corp., Milwaukee, Wis.
340-342—Boston Gear Works Sales Co., Norfolk Downs, Mass.
343—Marlin Rockwell Corp., Chicago, Ill.
343—Standard Steel and Bearings, Inc., Plainville, Conn.
344-345—Bartlett Hayward Co., Baltimore, Md.
346-347—Wm. B. Connor, Inc., New York, N. Y.
401—Peerless Machine Co., Racine, Wis.
402-403—Crankless Engine Co., New York, N. Y.
404-405—Hahn Engineering Co., Philadelphia, Pa.
406—Vulcan Radiator Co., Hartford, Conn.
407—Donnelly Systems Co., New York, N. Y.
407—Strong-Scott Mfg. Co., Minneapolis, Minn.
408—Flexitallic Gasket Co., Camden, N. J.
408—Metalastic, Inc., Jersey City, N. J.
409—Rollway Bearing Co., La Crosse, Wis.
410—Imperial Coal Corp., New York, N. Y.
411-414—B. F. Sturtevant, Hyde Park, Boston, Mass.
415—Ren Mfg. Co., Winchester, Mass.
416—The Libbey Glass Mfg. Co., Toledo, Ohio.
417—Charles Engelhard, Inc., New York, N. Y.
418-419—Smoot Engineering Corp., New York, N. Y.
420—Cork Foundation Co., New York, N. Y.
421-422—The Terry Steam Turbine Co., Hartford, Conn.
423—Ackerman-Johnson Co., Chicago, Ill.
424—S. F. Bowser & Co., Ft. Wayne, Ind.

425—Kingsford Foundry & Machine Works, Oswego, N. Y.
426—Key Boiler Equipment Co., East St. Louis, Ill.
427—Hanson & Yorke Co., New York, N. Y.
427—Sumet Corp., Buffalo, N. Y.
428—Homestead Valve Co., Homestead, Pa.
429—Trill Indicator Co., Corry, Pa.
429-430—American Machine & Foundry Co., Brooklyn, N. Y.
431—M. B. Skinner Co., Chicago, Ill.
432—Scandia Mfg. Co., Newark, N. J.
433—Moore Steam Turbine Corp., Wellsville, N. Y.
434—Alexander Brothers, Philadelphia, Pa.
435—Liberty Electric Corp., Stamford, Conn.
436—E. B. Badger & Sons Co., Boston, Mass.
437—Insulating Products Corp., New York, N. Y.
438-439—Irving Iron Works Co., Long Island City, N. Y.
440—Andrew C. Campbell, Inc., Bridgeport, Conn.
441—Triplex Machine Tool Co., New York, N. Y.
442—Bilton Machine Tool Co., Bridgeport, Conn.
442—Ex-Cell-O Tool & Manufacturing Co., Detroit, Mich.
442—Wisconsin Electric Co., Racine, Wis.
443—Speednut Wrench Corp., New York, N. Y.
444—International Trade Press, Inc., New York, N. Y.
445-446—The Louis Allis Co., Milwaukee, Wis.
447—Naugatuck Mfg. Co., Naugatuck, Conn.
448—Carbondale Grate Bar Co., Scranton, Pa.
449—McDonald & Co., New York, N. Y.
450—Brown Hoisting Machinery Co., Cleveland, Ohio.
451—Armstrong Mfg. Co., Springfield, O.
451—Kitts Steam Specialty Co., Oswego, N. Y.
451—Pitts & Kitts Mfg. and Supply Co., New York, N. Y.
452—Production Machine Co., Greenfield, Mass.
453—John W. Kittredge, Atlanta, Ga.
454—Consolidation Coal Co., New York, N. Y.
461—Erie Malleable Iron Co. (Kondu Div.), Erie, Pa.
462-463—Public Service Production Co., Newark, N. J.
464—Bird-Archer Co., New York, N. Y.
465—The Frederick Iron & Steel Co., Frederick, Md.
467—Timken Roller Bearing Co., Canton, Ohio.
469—Spray Engineering Co., Boston, Mass.
470—Allis-Chalmers Co., Milwaukee, Wis.
471—Hendrick Manufacturing Co., Carbondale, Pa.
472—The Trane Co., La Crosse, Wis.
473—Benjamin F. Shaw Co., Wilmington, Del.
474—T. B. Woods Sons Co., Chambersburg, Pa.
475—American District Steam Co., North Tonawanda, N. Y.
476—Accurate Brass Casting Co., Brooklyn, N. Y.
477-478—Metropolitan Brass Founders Association, Brooklyn, N. Y.
479—Wickes Boiler Co., Saginaw, Mich.
480—Kieley & Mueller, Inc., New York, N. Y.
481—Bolinders Co., Inc., New York, N. Y.
482—Coffin Valve Co., Boston, Mass.
483—A. Allan & Son, Harrison, N. J.
484—The Nitrose Co., Peoria, Ill.
485-486—Wilson Welder & Metals Co., Hoboken, N. J.
487-490—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
491—Ruths Accumulator Corp., Ltd., New York, N. Y.
492—Simplex Oil Heating Co., Providence, R. I.
493—The D. T. Williams Valve Co., Cincinnati, Ohio.
494—G. M. Davis Regulator Co., Chicago, Ill.
495—The Wm. Powell Co., Cincinnati, Ohio.
496-497—Heine Boiler Co., St. Louis, Mo.
498—General Refractories Co., Philadelphia, Pa.
499—The Toledo Pipe Threading Mach. Co., Toledo, Ohio.
500-501—Durabla Manufacturing Co., New York, N. Y.
502—The M. A. Hofft Co., Indianapolis, Ind.
503—Detroit Twist Drill Co., Detroit, Mich.
503—Torchweld Equipment Co., Chicago, Ill.
503-504—Topping Bros., New York, N. Y.
504—Bearium Bearings Co., New York, N. Y.
504—Templeton, Kenly & Co., Ltd., Chicago, Ill.
505—The Garlock Packing Co., Palmyra, N. Y.
506—Weston Electrical Instrument Corp., Newark, N. J.
507—Taylor Instrument Co., Rochester, N. Y.
508-509—Johns-Manville, Inc., New York, N. Y.
510—American Temperature Indicating Co., Toledo, Ohio.
510—E. Vernon Hill Co., Chicago, Ill.
511-513—Worthington Pump & Machinery Corp., New York, N. Y.
514-515—Bethlehem Steel Co., Bethlehem, Pa.
516—Ludeman Bros., New York, N. Y.
517—National Lead Co., New York, N. Y.
518—Sterling Engine Co., Buffalo, N. Y.
519—Union Iron Works, Erie, Pa.
520—Vastine Sales Corp., Chicago, Ill.
521—The National Acme Co., Cleveland, Ohio.
522-523—Bethlehem Steel Co., Bethlehem, Pa.
524-525—American Resistor Co., Milwaukee, Wis.
526-527—Pratt & Whitney Co., Hartford, Conn.
528-529—Niles-Bement-Pond Co., New York, N. Y.
530-531—The American Pulley Co., Philadelphia, Pa.
532—The Cooling Tower Co., New York, N. Y.
533—Ilg Electric Ventilating Co., Chicago, Ill.
534—Strom Ball Bearing Co., Chicago, Ill.
536-543—DeLaval Steam Turbine Co., Trenton, N. J.
540—DeLaval Separator Co., New York, N. Y.
544—Federal Gauge Co., New York, N. Y.
545-546—Schutte & Koerting Co., Philadelphia, Pa.
547—Barco Manufacturing Co., Chicago, Ill.
548—The Roberts Steam Specialty Co., Cleveland, Ohio.
549—W. A. Jones Foundry & Machinery Co., New York, N. Y.
550—Bassick Mfg. Co., Chicago, Ill.
551—The Hydraulic Press Mfg. Co., New York, N. Y.
552-553—Atwood & Morrill Co., Salem, Mass.
554-555—Mueller Metals Co., Ltd., Port Huron, Mich.
556—Foote Bros. Gear & Machine Co., Chicago, Ill.
557—Hanson Whitney & Co., Hartford, Conn.
The Whitney Mfg. Co.
559-560—Ruggles-Klingemann Mfg. Co., Salem, Mass.
562—Manistee Iron Works, Manistee, Mich.
563—Bishop & Babcock Mfg. Co., Cleveland, O.
564-565—Centrifix Corp., Cleveland, Ohio.
566—Murray Conduit Systems, New York, N. Y.
567—Botfield Refractories Co., Philadelphia, Pa.
568—W. D. Cashin Co., Boston, Mass.
569—Queen's Run Refractories Co., Inc., Lock Haven, Pa.
570—Goodman S. Fabian, New York, N. Y.
575—Sweet & Doyle Fdy. & Mach. Co., Troy, N. Y.

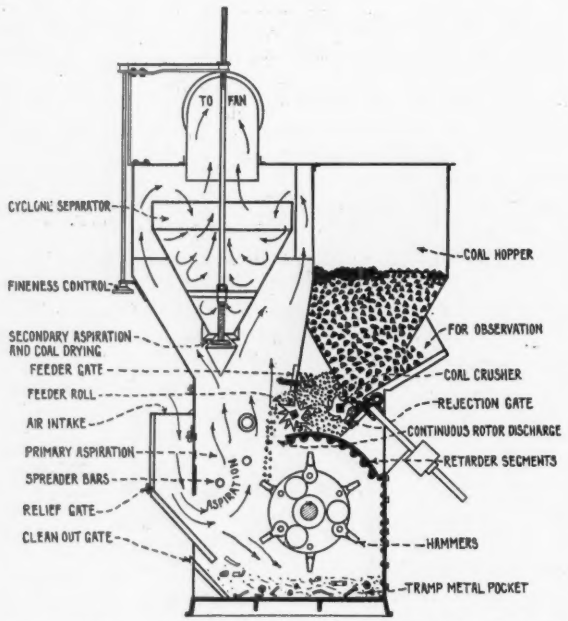
THE MISSOURI HYDRO-ELECTRIC CO., organized about a year ago, will proceed with the construction of a hydroelectric generating plant on the Osage River between Bagnell and Warsaw, Mo., for which plans have been in preparation for a number of months. The initial work will cover the construction of a power dam, 100 ft. high and 2400 ft. long, joining two mountains at a comparatively narrow gap in the Osage River Basin, and the creation of an artificial lake, said to be designed as the largest such body of water in the world, with a shore line 260 miles in length. A tract of close to 100,000 acres of land is being purchased for this lake, of which about 65,000 acres have now been cleared. The power station, as now projected, will have a capacity of about 100,000 hp., with this rating to be increased at a later date. A steel tower transmission line will be built. It is purposed to merge the project later with several other units in this part of the country, a new corporation to be formed under the name of the Super-Power Corporation of Missouri for such purpose. The present project is reported to cost between $45,000,000 and $50,000,000. A contract for the power dam has just been awarded to the Bickel Contracting Co., Kansas City, Mo. The Charles B. Hawley Engineering Corporation, Munsey Building, Washington, D. C., is engineer for the enterprise, and purchases of all hydraulic and hydroelectric power equipment will be made from this office.

THE CONNECTICUT LIGHT & POWER CO., Waterbury, Conn., operated by the United Gas Improvement Co., Philadelphia, Pa., has concluded negotiations for the purchase of the plant and property of the Bristol & Plainville Electric Co., operating at Bristol, Plainville and Terryville, Conn., for a consideration stated at close to $3,000,000. The purchasing company will take immediate possession and will continue the utility as a part of its system. Plans are completed for an addition to the steam-operated power plant of the Connecticut company at Devon, Conn., to include the installation of additional boilers, a 28,000-kw. generating unit, and auxiliary equipment. This station is one of the largest plants of its kind in New England, and was completed about two years ago. The company is also considering a hydroelectric power development on the Housatonic River, where it has a number of power sites. The project will include an additional transmission line, substations, etc., with accessory equipment. Irvin W. Day is vice-president.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Unit Pulverizer Uses Air Separation Principle

IN DESIGNING the Unipulvo, a unit pulverizer recently placed on the market, it was one of the principal aims of the manufacturers, in addition to incorporating features of design different from other equipment of this type, to design and build a machine of which every part,



AFTER PASSING AROUND ROTOR, MIXTURE OF AIR AND PULVERIZED COAL PASS TO SEPARATION CHAMBER, WHERE FINES ARE REMOVED

except possibly the main castings, could be repaired or replaced by any local machine shop, thus eliminating the need for factory service. The accompanying illustration shows the construction and principle of operation of the Unipulvo unit pulverizer.

From the coal hopper, coal passes through the crushing and mixing roll, which is designed to handle 3-in. lumps, to reduce the oversize usually found in screenings and to mix the coal thoroughly for presentation to the feeder. The crusher operates against a hinged rejection gate, which will yield to the pressure of any uncrushable object, either allowing it to pass or ejecting it from the machine. This provision is designed to eliminate the need for magnetic separators.

The wing type feeder, actuated by a pawl and ratchet mechanism that can be set to feed at any desired rate, operates against spring-retained plates, as shown. From the feeder, the coal is fed in front of the rotor, which is of the swing hammer type, carried on ball bearings. The latter revolves in an enlarged chamber in which there is a bed of coal six or eight inches deep at the bottom and which is entirely open on the air inlet side.

All air for combustion is taken into the rotor chamber with the coal feed and is swept around the rotor once, discharging at the top into the expansion and separating chamber, as shown by the arrows. The rotor is designed to act as a fan to create a cyclonic air action in the chamber. The sweep of the air draws the oversize returning from the separating chamber, as well as the coal fed into the mill, around the rotor and against the stationary coal, the only grinding action being that of coal on coal.

This air-swept mixture is discharged in a continuous stream into the separating chamber, where the fines go out with the air to the exhaust fan and thence to the burner, while the coarse particles drop back for further grinding. A blast gate in the fan intake regulates the amount of air taken through the mill and the fineness of pulverizing is controlled by raising and lowering the cone in the separating chamber. Tramp metal or rock that is not thrown out at the rejection gate settles to the bottom of the machine, out of contact with the rotor, and can be removed even during operation.

Crusher and feeder elements are designed to fit on square shafts and to be easily replaceable by pulling the shaft out through the side of the machine. The entire rotor chamber is made accessible by pulling two slides; the pins on which the hammers swing come out through the side of the machine to make hammer replacement easy. Crusher and feeder shafts are driven through a friction reduction drive.

The Unipulvo unit pulverizer is covered by extensive patents in this and other countries, it is stated. It is manufactured by the Strong-Scott Manufacturing Co., Minneapolis, Minn.

New Hand Stoker Is Self-Cleaning

ORDINARILY with hand firing there is more or less difficulty with clinker clogging up air openings and the slice-bar must be used frequently. With the new hand stoker now being introduced by the Kelly Foundry and Machine Co., of Goshen, Ind., it is stated that need for the tedious labor of a slice-bar as been eliminated and that a grate surface has been developed which will give a minimum amount of carbon siftings in the ash pit. Figure 1 shows the grate surface in normal position. Grates may be made in any width and depth, depending on the type and capacity of the boiler. The grate surface has a pitch of 4½ in. per foot, which permits progressive combustion as the fuel

is moved downward by raising alternate sections of movable grate bars.

As shown in Fig. 2, the entire grate surface is divided into two parts. On the outside of the cast-iron front, in the center, are four levers for operating the movable grate bars. Two are for the right hand side and the other two for the left. On each side, one lever operates the first,

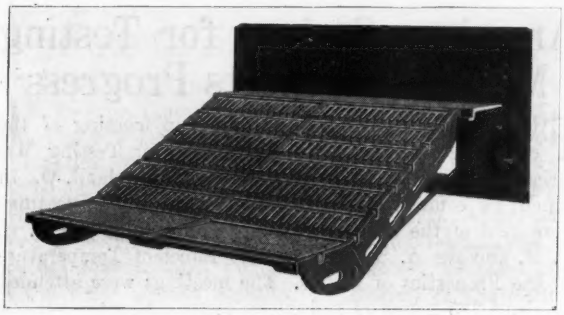


FIG. 1. NORMAL GRATE SURFACE; INCLINED 4½ IN. PER FOOT

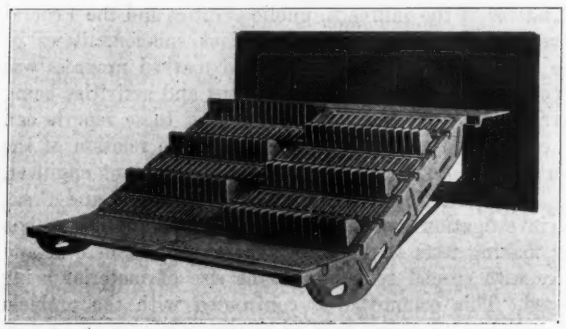


FIG. 2. RAISING ALTERNATE ROWS OF GRATE BARS PROVIDES SUCCESSIVE STAGES OF COMBUSTION. MOVABLE BARS MESH WITH STATIONARY, MAKING GRATE SURFACE SELF-CLEANING

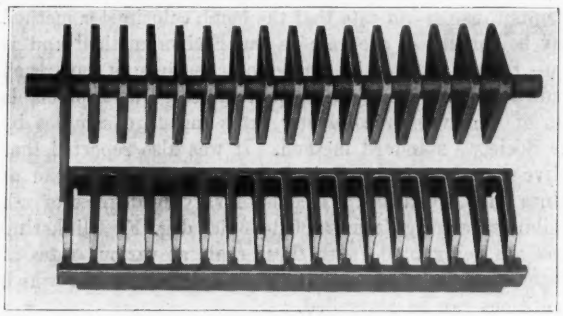


FIG. 3. FIRE SURFACE OF GRATE BARS; UPPER—MOVABLE BAR, LOWER—STATIONARY BAR

third and fifth bars while the other operates the even numbered bars. At the top of Fig. 3 is shown one of the movable bars and below one of the stationary bars, the ribs of the movable bar meshing with those of the stationary bar.

This type of stoker is used only with natural draft, coal being fired by hand. After the grate surface has been covered and a good fire started, a charge of coal is put through each of the fire doors onto the dead plate. Here it is allowed to coke partially, then a slight push of hoe or rake will scatter it onto the grate. This fuel is then moved downward and enters into successive stages of combustion by the action of the bars previously mentioned.

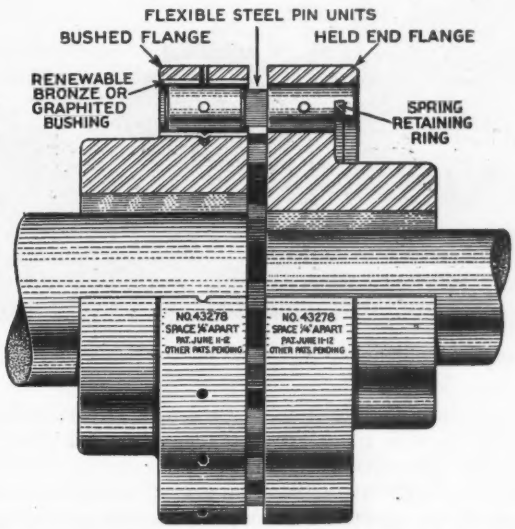
As these bars move upward, the positive shearing action of the ribs breaks up all clinker and provides a maximum amount of air opening at all times. These movable bars are so balanced that, as soon as the operator releases his hold on the lever, they drop back into normal position. This forestalls carelessness on the part of the operator for, if the bars were not lowered immediately after breaking up the fuel bed, the intense heat would soon burn the ribs.

Ash accumulating at the rear is dumped into the pit by action of the cast-iron trays shown in Fig. 2. There is one tray to each half of the stoker and dumping is effected by levers at the front.

Any kind of coal, coke or wood refuse may be burned. Slack coal of the hard caking variety burns as readily as selected nut or egg size.

Improvements in Francke Couplings

IMPROVEMENTS have been made in the Francke flexible coupling, manufactured by Smith & Serrell, Newark, N. J., which are being incorporated in a new line of couplings to be known as the bushed pin type. This new


FLEXIBLE STEEL PIN UNITS
BUSHED FLANGE
HELD END FLANGE
RENEWABLE BRONZE OR GRAPHITED BUSHING
SPRING RETAINING RING
NO. 43278 SPACE ½" APART PAT. JUNE 11-12 OTHER PATS. PENDING
NO. 43278 SPACE ½" APART PAT. JUNE 11-12 OTHER PATS. PENDING

PART SECTION OF IMPROVED FRANCKE FLEXIBLE COUPLING

type retains the best features of the old heavy pattern type but adds several new features which diversified use has indicated as desirable. More and easier endwise movement has been provided, also greater power and bore capacities.

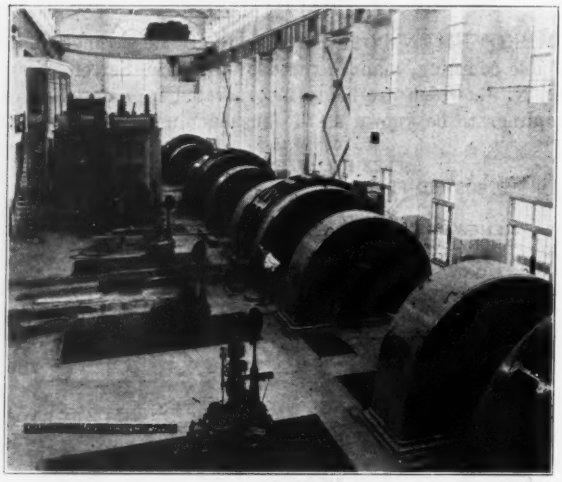
In the larger sizes graphited bronze bushings are used which are removably locked in one flange. The steel pin units are free to slide ½ in. within these bushings; contact surfaces are more than doubled; a cylindrical surface is obtained; movement is between steel and bronze; and the graphited bushings present a self-lubricated surface that lasts for a long period.

Francke couplings are designed for use on motor, turbine and engine drives to handle all accidental misalinements, to cushion starting and load shocks, and absorb vibrations. They run without noise and are applicable to motion in either direction.

Four Units Now Installed at Moccasin Creek

AS SHOWN in the accompanying illustration, the Moccasin Creek power house of the Hetch Hetchy Water Power development of the city of San Francisco contains at present four of the six 20,000-kv.a. hydro-electric generating units ultimately called for by the design of the station. As explained in the May 15, 1923, issue of Power Plant Engineering, these units are of the double overhung Pelton type, with direct connected exciter on one end of the shaft, operating under a head of 1315 ft. They operate at 257 r.p.m. and the generators are rated at 20,000-kv.a. at 87½ per cent power factor, 11,000 v., 60 cycles. Power from this plant is transmitted at 154,000 v. by a 140-mi. steel tower transmission line.

Production of power in the Hetch Hetchy project is only a part of the scheme, which is being carried out primarily to bring water into the city of San Francisco.



HYDRO-ELECTRIC GENERATORS AT MOCCASIN CREEK

Since this water comes from a considerable elevation above the city, however, advantage was taken of its fall by using its energy for power production.

By the time this article appears, it is expected that repairs to the penstocks and equipment damaged during an accident at the plant several weeks ago will have been completed and that the four units shown above will be in regular operation. The accident at Moccasin Creek occurred while the plant was in the final stages of construction; two of the four generating units were running preparatory to going on the line and a third unit, which had been shut down for inspection, was being prepared for starting again. In operating the 36-in. valve at the power house end of the penstock, the operator failed to open the bypass before opening the main valve. The latter, which had not been properly timed, opened too rapidly, causing a severe surge in the 66-in. lap welded steel penstock, which ruptured about 1000 ft. above the power house. About 20 min. later, a second penstock leading to one of the other units, weakened by the first water hammer and by the normal surges caused by shutting down the unit on this line, ruptured at almost the same distance from the power house.

Since the control valves at the upper ends of these penstocks had not been connected up, it took some time to shut off the water and meanwhile the flood of water had rushed down the hillside carrying dirt, trees and other debris. This caused considerable damage to the power house, partially flooding the lower parts of the generator windings, the oil pumps and other auxiliaries and filling the power house basement with mud and trash.

American Society for Testing Materials Reports Progress

FROM OCTOBER 27 to 29, a group meeting of the committees of the American Society for Testing Materials was held at the Hotel Cleveland, Cleveland, O., in which 14 committees took part. In addition, meetings were held of the Joint Research Committee of the A. S. T. M. and the A. S. M. E. on the Effect of Temperature on the Properties of Metals. The meetings were attended by about 275 members and guests representing the various industries concerned, such as the producers of iron and steel, non-ferrous metals, gypsum, cement and rubber products, the electrical industries and including representatives of the railroads, public utilities and the Federal government. Meeting of the various sub-committees of the main committees were held and marked progress was reported in the various investigations and activities being carried on by the Society. Only two of these reports can be commented on here, but they show the relation of the work of the Society to that of the power plant engineer.

At the meeting of Committee D-5 on Coal and Coke, an investigation was reported of the optimum size of box for making tests on weight of one cubic foot of coal and coke with special reference to the size of material being tested. This committee is confronted with the problem of deciding on round-hole or square-hole screens or perhaps both. The Sub-Committee on Sulphur Determination reported that the committee had made sulphur determinations by both the standard Eschka method and by the bomb calorimeter method on a series of standard samples. Results thus far indicate that the bomb calorimeter method may be equally as accurate as the Eschka method and is more rapidly made. A number of experiments have been made at the Bureau of Mines that indicated no appreciable loss of moisture in collecting gross moisture samples by the Society's standard method. It was also reported that active experimental work is in progress at the Bureau of Mines with a series of six coals of varying degrees of ash fusibility ranging from 2000 to 3000 deg. F. Clinkering tests are being made with these coals at various rates of combustion in a special experimental furnace in which conditions can be controlled.

The Joint Research Committee on the Effect of Temperature on the Properties of Metals was organized early in 1925 to meet the need for extensive study of the properties of metals at high temperatures brought about by the increasing number of power plants, oil refineries and the like operating at high temperatures and pressures. A report by the Sub-Committee on Procurement of Materials indicates that manufacturers are eager to co-operate by supplying the necessary materials for physical tests.

Between 20 and 30 co-operating laboratories are already equipped to handle high-temperature tests, and practically all of these have offered the use of their facilities. Twelve of these laboratories were selected for the

first group of high-temperature tests and the material on hand will be distributed to them when heat-treated and machined, with the tentative specifications for tests, so that they may proceed with the active work on these materials.

Trenton Channel Prepares for Fourth 50,000-Kw. Unit

WORK IS progressing rapidly on the extensions to the Trenton Channel station of the Detroit Edison Co., which is now being enlarged to include a new turbo-generator unit with its auxiliary equipment, together with the boiler equipment to supply it. Already there are about 400 men employed on this construction work. At present, work is being done on the buildings and foundations to house a fourth 50,000-kw. turbo-generator, the same size as the three already installed. Extension to the switch house, coal unloading pit, coal breaker and conveyor house and coal preparation plant are also under way. While present plans call for installing only one more turbine at this time, the turbine house substructure and superstructure are being extended to accommodate a total of six machines, which will give the station an ultimate capacity of 300,000 kw. The turbine room substructure is now about 70 per cent complete. The substructure for the coal unloading house and coal preparation house extensions is practically finished. The boiler room foundation is also being enlarged to twice its present size and excavating work for this extension will be started shortly, reports the Detroit Edison Synchroscope.

At Trenton Channel, the coal pulverizing mills are equipped with the air separation system, in which a fan draws air through the mill and discharges it to a cyclone separator, from which the air returns to the mill. This fan, therefore, handles dust-laden air and the erosive action of the coal dust is considerable. For that reason the fan casing is equipped with removable cast-iron liners and these as well as the fan blades must be renewed rather frequently. Three requirements must be fulfilled by a satisfactory material for fan blades, namely: (1) sufficient mechanical strength to withstand the forces due to rotation, (2) a surface that will withstand the erosive action of the coal dust and (3) in case of renewal, a not too difficult method of attaching new blades to the spider. Various materials have been tried to reduce this erosion to a minimum. Special rubber coated blades were tried recently but the rubber did not adhere uniformly to the steel, and after a few hours' service, was thrown off one blade. It did stick to the others, but the rubber showed cracks in the surface.

During the month the work of rebuilding a commutator on No. 1 direct current unit was completed and this machine is again in service, while No. 2 direct current unit is down to re-aline the turbines and gear casing.

Changes in the sealing system for the main units were also completed recently. Water to the seals on all three machines was formerly supplied from one header; it was found, however, that the consumption of this sealing water on a machine during the starting period was so great as to reduce materially the pressure in the header and thus rob the other machines in service, resulting in some cases in a drop in vacuum. With the new arrangement, the water is discharged from the header into a head tank for each machine located some 38 ft. above the center of the turbine, the level in the tanks being maintained by float control. This arrangement insures a constant head on the seals of each machine independent of the other machines.

Engineering Council to Analyze Giant Power Report

AT ITS meeting in Columbus, Ohio, October 29 and 30, the Administrative Board of the American Engineering Council authorized the appointment of a committee to review and analyze the Giant Power Report issued by Governor Pinchot of Pennsylvania. The reviewing committee is to be chosen by the Executive Committee of the Council, to which it is to report at the earliest practicable moment.

This action followed representations that the Giant Power Report contains economic fallacies likely to mislead the public. The aim of the analysis is to provide a popular interpretation of the report from an engineering standpoint.

Plans contemplating a nationwide study of public utilities were set in motion by the Board, which voted to appoint a committee to determine a definite scheme of investigation and report to the Council at its annual meeting in Washington early in January.

On the committee, which will submit a program for the consideration of the Council, are Dean Dexter S. Kimball of Cornell University and Fred J. Miller, both past presidents of the American Society of Mechanical Engineers; A. W. Berresford of Niagara Falls, N. Y., American Institute of Electrical Engineers, and Lawrence W. Wallace of Washington, executive secretary of the American Engineering Council.

Questions confronting the engineers, should the Council decide to undertake the study, involve where federal regulation should end and municipal regulation begin; what should be the policy with reference to regulation of interconnected systems; whether methods of regulation should be written into state constitutions; theories of valuation; theories of rate making, and the standards of service required by federal and state commissions.

Cost of the survey was estimated at from $25,000 to $35,000. Action of the Administrative Board followed a recommendation by its Executive Committee that the American Engineering Council undertake a survey of "the regulation of public utilities."

The Board voted to press the Council's effort in the field of U. S. Government reorganization, and authorized the presentation at the next session of Congress of a bill establishing a Division of Public Works in the Department of the Interior. This measure will be introduced in the Senate by Senator Wesley L. Jones of Washington, Chairman of the Senate Commerce Committee, and in the House by Representative Adam M. Wyant of Pennsylvania, chairman of the Interstate and Foreign Commerce.

Allen A. Tirrill Is Dead

ALLEN A. TIRRILL, 52 yr. old, the inventor of the Tirrill voltage regulator died recently. For many years Mr. Tirrill was associated with the General Electric Co., Schenectady, N. Y., and in 1910 became an engineer at the Westinghouse Electric & Mfg. Co. He left the company in 1916, but since that time had been one of its consulting engineers.

He built the first dynamo and installed the first electric lights at Stewartstown, N. H., and constructed virtually all of the water power plants in northern New Hampshire. In 1897 he put in the first voltage regulators in Lakeport and Concord, N. H. Mr. Tirrill sold his patents to the General Electric Co. in 1902, and in 1910 the company sent him on a tour of Europe to demonstrate the practicability of the regulator. In 1914 he was awarded the John Scott legacy medal for his meritorious inventions, together with a diploma. He was a member of the American Institute of Electrical Engineers and St. John's Lodge No. 48, I.O.O.F., of New Hampshire.

William J. Wickes Dies

WILLIAM J. WICKES, president of the Wickes Boiler Co., Saginaw, Mich., and vice president of Wickes Brothers, died suddenly of heart disease on Nov. 1. Born in 1862, Mr. Wickes entered the business of Wickes Brothers which was owned by his father and uncle when he was but 16 yr. old. When the Wickes Boiler Co. was organized in 1907, he was made president of that company and held that position until his sudden death last month. He was also president of the Consolidated Coal Co. of Saginaw and the U. S. Graphite Co. He was vice president and director of the Bank of Saginaw and for ten years was president of the Saginaw Plate Glass Co. Mr. Wickes is survived by his widow, three sons and three daughters.

Engineers Club to Hold Power Conservation Meeting

CONSERVATION OF POWER in industrial plants is to be studied at a conference to be held by the Engineers Club of Philadelphia on Feb. 16, 1926. The tentative program, which has recently been announced, is as follows:

"When Is the Private Power Plant Justified?" by David Moffat Myers, consulting engineer, New York.

"Operating a Private Power Plant in Competition with Purchased Power," by Thomas V. Balch, supervising engineer, Equitable Office Bldg., New York.

"When Is Purchased Power Justified?" Name of the principal speaker not yet determined.

"High Pressure Prime Movers in Industrial Plants," by J. F. Johnson, Westinghouse Elec. & Mfg. Co.

"Use of Exhaust Steam for Process Work in Textile Plants," by Samuel M. Greene, consulting engineer, Springfield, Mass.

"Heat Insulation," by L. B. McMillan, chief engineer, Johns-Manville, Inc., New York; R. H. Heilman, Mellon Institute of Industrial Research, Pittsburgh.

"Power Transmission Economies," by William Staniar, transmission engineer, DuPont Co., Wilmington, Del.

"Lubrication and Bearings," by John D. Gill, Atlantic Refining Co., Philadelphia.

"Plant Illumination." Name of principal speaker not yet determined.

"Economy in the Use of Power." Under this head there will be addresses on "Load Factor," "Power Factor," "Economical Voltages."

ALUMINUM fittings should be used with aluminum pipe, wherever possible, in order to reduce the liability of galvanic action.

News Notes

HENRY H. NORRIS has been appointed educational adviser to the Boston Elevated Railway.

MCCLAVE BROOKS Co. announces the appointment of Irwin R. Hoffman as manager of its Buffalo office.

KARL MACDONALD has accepted a position as mechanical engineer with the Moore Steam Turbine Corp. of Wellsville, N. Y.

EDWARD L. CHAMPION, formerly with the Light & Power Dept., Los Angeles, Calif., has become associated with the condenser department of the Ingersoll-Rand Co. of New York.

THE LEAVITT MACHINE Co., Orange, Mass., has recently appointed the McQuaide Belting Co., 103 Virginia St., Charleston, W. Va., as sales representative for the state of West Virginia.

OIL AND Gas Power Week has been set forward for 1926 to April 19—24. During this week, meetings will be held throughout the country on the use of oil and gas for power, 27 sponsor societies taking part in the arrangements to make the work of the week successful.

THE UNITED STATES FEDERAL Trade Commission has handed down a decision dismissing a complaint against the Permutit Company that it was guilty of unfair trade practice. This decision was made on the 20th of October, after a hearing at which nearly 100 witnesses were examined.

ANNOUNCEMENT HAS RECENTLY been made by T. N. Wynne, second vice-president of the Indianapolis Light & Heat Co., that this company is about to commence work on the installation of the new Mill Street, Indianapolis plant, which will contain three 1057-hp. Stirling boilers. These boilers will be equipped with Foster water-cooled side walls and Riley underfeed stokers. The stacks serving these boilers will be 250 ft. high and 15 ft. in diameter.

AT A RECENT meeting of the Board of Directors of The Prest-O-Lite Co., Inc., M. J. Carney, formerly president, was elected chairman of the Board. William F. Barrett, formerly vice-president, was elected to the presidency. Ralph R. Browning was elected vice-president in charge of acetylene sales activities and R. J. Hoffman was re-elected vice-president in charge of storage battery and automotive divisions.

THE ROLLER-SMITH Co., of New York City, announces that its Knoxville, Tenn., agent, The Tennessee Engineering & Sales Co., has opened a branch office at 493 North Blvd., Atlanta, Ga., to take care of business in that state. The Detweiler-Bell Co., the New England agent for the Roller-Smith Co., now has its office at 101 Milk St., Boston, Mass., and a branch office at 152 Temple St., New Haven, Conn.

H. M. BYLLESBY & Co. has recently announced the purchase of the St. Paul Gas Light Co. by the Northern States Power Co. The St. Paul Gas Light Co. supplies all of the gas service and approximately 70 per cent of the electric light and power service to the city of St. Paul, Minn. This company's property includes both steam and hydroelectric generating stations and a gas plant with a daily manufacturing capacity of 10,000,000 cu. ft. and also has a contract for the purchase of coke oven gas which provides for about 75 per cent of its total gas output. The company was previously controlled by the American Light & Traction Co. of New York and A. R. Lathrop was president of both corporations.

CASCADE ELECTRIC Co., Grand Rapids, Mich., has sold to W. G. Yates, 16 Lafayette Street, same city, water rights on the Cascade River about 10 mi. east of Grand Rapids and it is understood that Mr. Yates will at once undertake hydro development of about 2500 hp.

AT THE LAST meeting of the Board of Directors of The Linde Air Products Co., G. W. Mead, formerly president, was elected chairman of the Board. W. F. Barrett, formerly vice-president, was elected to the presidency. In addition to these changes R. R. Browning was elected vice-president in charge of sales activities, and J. A. Rafferty, as vice-president in charge of engineering, manufacturing and research.

BOARD OF PUBLIC WORKS, Holland, Mich., is reconstructing the city's light and power plant by installing two 500-hp. Stirling boilers equipped with super-heaters and Taylor stokers to be operated at 225-lb. pressure with 100 deg. superheat and by the further edition of 2500-kw. G. E. turbine. Concluding this program the plant will have a capacity of 5500 kw. with an ultimate capacity for enlargement of approximately 9000 kw. The plant is the only source of power in Holland and during construction period will be in continuous operation. Burd-Giffels & Hamilton, consulting engineers, Grand Rapids, Mich., have designed and are executing the work.

THE J. G. WHITE ENGINEERING CORPORATION, New York, is completing arrangements for the purchase of the Northern Connecticut Light & Power Co., Thompsonville, Conn.; the Thompsonville Water Co., Thompsonville; and the Stafford Springs Aqueduct Co., Stafford Springs, Conn.; and will consolidate under one management. A consideration of about $1,000,000, it is stated, will be given for the properties. The purchasing company has plans in prospect for expansion in the different organizations, including extensions in the hydroelectric power station near Enfield Falls on the Connecticut River, a development of the first noted company.

THE CONSOLIDATED GAS, Electric Light & Power Co., Lexington Building, Baltimore, Md., is arranging an expansion and improvement program for the remainder of the present year and 1926, to cost from $9,000,000 to $10,000,000. The work will include extensions to present steam-operated generating plants, additional substations and transmission lines, distributing lines, etc. The company proposes to issue stock in an amount of about $4,909,000, at an early date, with additional stock issues later. Herbert A. Wagner is president.

THE WICHITA HOSPITAL, Wichita, Kans., operated by the Sisters of St. Joseph, is installing an 80-hp. Kewanee boiler for heating purposes and a steam line will be laid from the power plant to the nurses' home 600 ft. distant.

THE SOUTHERN POWER Co., Charlotte, has authorized immediate work on plans for a new steam-operated electric generating plant on local site. The station has been under consideration for a number of weeks past, and will be of 100,000-hp. capacity, instead of 80,000 hp., as originally projected. A contract for two 50,000-hp. steam turbo-generators has been given to the General Electric Co., Schenectady, N. Y., and it is purposed to place other contracts for auxiliary machinery in the near future. W. S. Lee is vice-president and chief engineer.

THE SOUTHERN CALIFORNIA EDISON Co. has authorized Stone & Webster, Inc., Boston, Mass., to proceed with the design and construction of an addition to its Long Beach Steam Plant No. 2, which will consist of the installation of a 50,000-kw. General Electric Co. turbo-generator and seven 1500-hp. boilers. The work will include extension to the condensing water tunnels and an addition to the fuel oil storage facilities. The electrical development will consist of a four-bay extension to the switch house, two additional outgoing feeders, and an additional 60,000-kv.a. transformer bank. It is expected that the new unit will be put into operation in the summer of 1926. The present station comprises two 35,000-kw. units and eight 1500-hp. boilers.

THE UNITED STATES CIVIL Service Commission announces the following open competitive examinations: Junior Mechanical Draftsman, Junior Electrical Draftsman and Junior Engineering Draftsman. The applications for the positions listed will close on December 15 and the examinations are held to fill vacancies in federal classified service throughout the United States. The entrance salary for these positions will be $1320 a year to start and after probational period of six months advancement in pay may be made without change in assignment up to $1680 a year. The duties of the positions are to make and revise tracings; to prepare miscellaneous simple detailed drawings from sketches; to file and index drawings; to make minor computations, and to perform related work as required. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C.

Books and Catalogs

HEAT TRANSMISSION OF INSULATING MATERIALS, by the Insulation Committee, American Society of Refrigerating Engineers; 114 pages, 8½ by 11 in., paper; New York, price $2.00.

One of the main purposes of the committee in preparing this book was to suggest methods of testing the heat transmission of insulating materials; for this reason, Section VI, which covers the plate method, and Section VII, which covers the box method, form the hub around which all the other sections revolve.

Sections II to V give the reader a clear mental picture of the mechanism of heat transfer, a correct understanding of heat transfer nomenclature, a full appreciation of the significance of surface effects and a familiarity with the technique of temperature measurement.

Since the book is intended and arranged to serve as a desk reference for the practicing engineer whose problems require the preparation of new insulation design or the checking of submitted or existing design, Section VIII covers the economics of insulation, Section IX summarizes in tabulated form the conductivity test values of insulating materials and their significant properties and Section X illustrates the method of computation for typical problems. Section XI gives an extensive bibliography of the subject, including a brief digest for most of the references. The book is illustrated with many drawings and half-tones.

THE AUSTIN BOOK of Buildings will be found of great interest by anybody who has to do with building construction or who is contemplating the erection of a building. Not only does it give a great number of illustrations of buildings of all kinds for all sorts of industries and purposes, but it has much special data on various types of building construction.

Some of the notable features are: Cost of building trend with illustrative chart for a 7-yr. period; trend as to multi-story and single-story buildings; decentralization trend in manufacture and distribution; comparative insurance rates; effect of soil bearing pressures on building costs; technical section showing advantages, costs and details for various types of floors, doors, walls, roofs, wall facings and waterproofings.

This book is attractive as well as instructive and from its 100 pages ideas may be gained on architectural as well as structural improvement.

Personal copies will be mailed to executives upon request to The Austin Co., Cleveland, Ohio.

IN AN ATTRACTIVE FOLDER, recently sent out by the Freeman-Riff Company, Terre Haute, Ind., are shown a number of views of the coal handling equipment installed at Purdue University. The steam employed takes the coal from the track hopper to the single roll crusher, then by a steel apron conveyor to a bucket elevator, thence to the steel flight conveyor, which distributes the coal into a suspension type steel bunker. The coal is weighed as it is withdrawn on its way to the stoker hopper.

THE HISEY-WOLF MACHINE CO., of Cincinnati, Ohio, has just issued its bulletin No. 108, describing the latest Hisey ⅝-in. capacity standard duty universal electric drill, which is equipped with motor drive.

HERMAN H. STICHT & CO., 19 Park Row, New York, describes in its bulletin B, recently published, uses for Stanco megohmers. These instruments are built in three different models and various ranges and are found particularly useful for testing insulation of motors and generators.

MARION HEAVY DUTY STOKERS, known as type "K", are described in a bulletin recently issued by the Marion Machine, Foundry & Supply Co., of Marion, Ind. These stokers are manufactured for either full mechanical, semi-mechanical or hand operation.

THE CUTLER-HAMMER MFG. CO., of Milwaukee, Wis., has recently issued its publication P-11, which illustrates and describes the many uses for Cutler-Hammer pneumatic clutches on synchronous motor drives, where the starting is severe, such as in cement, flour, paper and steel mill industries.

THE COMPLETE LINE of Toledo pipe threading tools and equipment is described in the new copy of the Toledo catalog, which has just been issued by the Toledo Pipe Threading Machine Co., Toledo, Ohio. The catalog is well illustrated and the text matter clearly written to describe the uses and construction of the various tools manufactured by this company.

ELECTRIC PYROMETERS of the newly designed recording type, manufactured by The Brown Instrument Co., of Philadelphia, Pa., are described in a bulletin recently issued by that company. This new line of pyrometers is the result of several years' research work by the company and, during the past year, the recorder has undergone endurance and accuracy tests in plants of practically all industries. These tests have resulted in a design which has a high degree of accuracy and is convenient and simple to care for.

THE CLAY PRODUCTS ASSOCIATION, Chamber of Commerce Bldg., Chicago, Ill., has recently issued a bulletin giving tentative standards for vitrified salt glazed clay sewer pipe and fittings, fire clay flue linings and fittings, flue or chimney pipe and fittings, wall coping and fittings and specifications for the laying of vitrified salt glazed clay sewer pipe. The association solicits the co-operation of engineers and architects in an effort to standardize this equipment and invites criticisms and suggestions of the tentative standards purposed.

BAILEY METER CO., of Cleveland, Ohio, is distributing a new booklet entitled "Fluid Meters for Steam and Water," in which the applications of meters for measuring steam, water, oil, brine and other fluids are pointed out. Recording and integrating meters, as well as pressure and temperature recorders, manufactured by this company, are described and illustrated. Considerable information is also given on the use of the orifice for measuring the flow of fluids. Other important subjects treated are orifice locations, meter connections, swirling flow and pulsating flow, all of which conditions affect the accuracy of flow measurement.

ANNOUNCEMENT HAS recently been made by MacRae's Blue Book Co., Chicago, Ill., that it has absorbed Hendricks Commercial Register. These two publications will be consolidated and appear under the title of "MacRae's Blue Book Consolidated with Hendricks Commercial Register." Hendricks Commercial Register began publication 35 yr. ago under the direction of S. E. Hendricks. MacRae's Blue Book was first published 12 yr. ago primarily intended for the steam and electric railroad field and was afterwards re-edited so as to cover the industrial field as well. The consolidated publication will blanket not only the steam and electric railroad field but also the worthwhile industries of American public utilities, chambers of commerce, etc.

EDGE MOOR IRON CO. of Edge Moor, Del., has just issued an attractive pamphlet dealing with the description of the Edge Moor single pass boiler, which has been recently placed on the market. This new type of boiler is without baffles and contains in one unit the boiler, superheater and economizer and is admirably adapted for use in central stations and large boiler plants.

BRIDGEPORT BRASS CO. has recently issued a bulletin in commemoration of its sixtieth anniversary. In this pamphlet is printed an account of the Bridgeport Brass Co. from its beginning in 1865 up to the present date. A copy of this interesting historical pamphlet may be had by anyone addressing the company at Bridgeport, Conn.

REPUBLIC FLOW METERS CO., Chicago, Ill., is issuing three series of articles in bulletin form. The first, dealing with boiler room operation, is prepared by G. F. Gebhardt; the second series deals with steel and its heat treatment and is prepared by H. M. Boylston, and the third is entitled "Heavy Clay Products and Their Manufacture" prepared by C. W. Parmelee. All of these men are well known to their fields and the material is prepared as a clean cut discussion of the latest developments in each of the three fields discussed.

ALLIS TEXROPE DRIVE is the subject of Bulletin 1228, recently issued by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. This bulletin not only describes the Texrope Drive and its application to many uses but gives considerable technical data which will aid the engineer in planning use of this new system of transmitting power between a motor and driven machine.